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Suburban Land Constraints And Intraurban Income Distribution

Timothy J. Bailey

SUBURBAN LAND CONSTRAINTS AND INTRAURBAN INCOME DISTRIBUTION

by

Timothy J. Bailey

Department of Geography

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ABSTRACT

This dissertation examines the effect of space restrictions on the intraurban distribution of socioeconomic groups. It proposes that the centripetal income shifts evident in North American cities with suburban containment can be explained in part within the context of traditional neoclassical theory. A model is introduced to predict the residential location pattern in a metropolitan center when suburban land consumption constraints and a polycentric urban form are incorporated into the Alonso budget equation (Alonso, 1964). In this model two things happen to higher socioeconomic groups with a fixing of the size of new lots; the accessibility variable rises in relative importance and the demand is refocused on the existing supply of large lots. Geographically, the higher income groups shift inward.

The model, based on the variables of residential space, accessibility and income, applies block-level data (for the most part) for Metropolitan Toronto. Site area, floor area or a composite area value measures residential space; distance from the core or an employment potential calculation quantifies relative accessibility; and, household income or dwelling value represents the latter variable.

Based on different combinations of the measures, iterations of the model predict theoretical incomes. These values and

their resultant spatial patterns are compared to the actual configuration. The goodness of fit and the applicability of the model's components are assessed using weighted least squares multiple regression and cluster analysis.

Empirical tests reveal that the representativeness of the predicted values are moderate when the metropolis is treated as an entity. However, analysis by socioeconomic sector indicates that the model's fit is much improved for the middle and upper income zones. When the predicted spatial patterns are compared to those of actual values, the quality of representation improves again. This is especially the case for the site area and composite area-based iterations. Further, examination of levels of similar accessibility shows greater revaluations for those cases with greater space. These results are significant at different levels of aggregation, and support the fundamental premise of the model. Overall, the model performs reasonably well.

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CHAPTER 1:

INTRODUCTION

Since the sixteenth century the form of open bounded Anglo Saxon cities has been one of progressively declining densities towards the perimeter of the urban region, and, within sectors, of increasingly higher economic status. This structure is also the city of the classical economic and sociological models. In many centers, however, this is changing. Pronounced upward shifts in income status are evident in some inner cities and their older suburbs. This poses an empirical dilemma which is often explained by shifting tastes in architecture and neighbourhood form, and enhanced employment opportunities in revitalized downtowns (Laska and Spain, 1980; Gale 1984; Ley, 1986; Filion, 1987). However, it may also be explained more simply within the traditional urban-economic models by constraining land consumption on the urban perimeter, such as would result from policies of peripheral containment. This dissertation proposes a model of urban socioeconomic shift, with land use control systems limiting the size and raising the values of the marginal lot increment.

The traditional urban-economic models argue that higher socioeconomic groups reside on the lower flanks of the density gradient as a consequence of the greater valuation of space over access (Alonso, 1960, 1964; Muth, 1961 1969; Thrall, 1987). In classical urban land rent theory, land value at a specific location is a function of its relative accessibility, and site cost is dependent on the quantity of land consumed. A central assumption in both classical and newer models is that new land for development is only constrained by accessibility i.e. there is a continual availability of land at the periphery of the built up urban area (Burgess, 1925; Hoyt, 1939; Alonso, 1960, 1964; Muth 1961, 1969; Beckmann, 1969; Gera and Kuhn, 1977; Thrall, 1987).

Nevertheless, suburban growth in most cities in Canada, some in the United States, and many in Europe take place within a planned environment which is generally subject to numerous constraints on lower density development. Peripheral expansion in Canada, for example, is regulated by land use control systems; these extend predevelopment delays, restrict outward growth, and through both direct and circuitous routes restrict lot sizes (Spurr, 1976; Frankena and Scheffman, 1980; Dowall, 1982). Spurr (1976) has shown that the Ontario government's plan approval process often took up to two years, with official plan and zoning amendments adding almost another year. Public policies aimed at halting spatial growth have lead to increased densities of housing, as has the goal to achieve efficient planning (with regard to the cost effectiveness of public services). Suburban expansion is further confined by transportation and service limitations, and developer constraints (Goldberg, 1978;

Fallis, 1981; Edmonston, Goldberg and Mercer, 1985). Past delays in the provision of trunk services in Toronto, for example, limited the supply of appropriate vacant land, subjected developers to more servicing requirements (to obtain plan approval) and thus contributed to increasing land prices (as supply failed to meet demand).

The post war years in Metropolitan Toronto, for example, have witnessed significant deviations from the traditional density profiles characteristic of North American cities. Low density peripheral construction, exemplified by post war large lot developments, were succeeded by the minimal lots and escalated prices evolving in the intensely contained Toronto of the early 1970s and late 1980s (Greenspan, 1978; Metropolitan Toronto Planning Department, 1987b). While these emerging space restrictions are not assumed in the existing classical models, their fundamental principles can provide an interpretation of inward socioeconomic restructuring.

As well, the empirical base is changing. The standard assumption of a monocentric city with employment, goods and services located solely at the core, is no longer applicable to the polycentric form characteristic of the typical North American urban region. Accessibility, traditionally dealt with in terms of distance from the historic core, needs to reflect the relative degrees of attraction of the multiple centers and their distance from the residential site in question. Similarly, the increasing size of the site (in the single detached dwelling category in particular) with increasing distance from the center can no longer be assumed due to potential suburban lot size restrictions.

It is the intent of the dissertation to illustrate the effect of the emerging space restrictions on the intraurban income distribution. A "centripetal shift" model is introduced to predict the residential location pattern within a polycentric metropolitan center when the multiple nodes of employment and services, and the effects of income and suburban land consumption constraints are incorporated in the location decision. A theoretical reorganization of higher socioeconomic groups is forecast.

The implication of restricting suburban lot sizes has both theoretical and empirical significance for intraurban income distribution, morphology and structure. Older areas containing larger lots are subjected to a revaluation, and the importance of a more central or closer to work location increases as the tradeoff between more land at the periphery and higher commuting costs ceases to exist. Large homes and lots located nearer the various employment centers increase in value relative to the surrounding areas, presumably (over the mid to long term) with associated increments in socioeconomic levels. The emerging urban form and the adjustment in location of households based on income drastically alters the organization of the city described and predicted by earlier models. In the model used in this dissertation two things happen to higher socioeconomic groups with a fixing of the size of new lots: the accessibility variable rises in relative importance, and the demand is refocused on the existing supply of large lots. Geographically, the higher income groups shift inward.

The resultant pattern contradicts existing models and helps explain the core convergence that is taking place in many Canadian cities. This premise is empirically tested, based on the residential situation existing in Metropolitan Toronto.

Initially, the patterns of change of single detached dwelling values and their percent change for the period from 1961 to 1986 are described. These values are converted to a relative form, to increase the ease of comparison. It is the relative structure and distribution of values and the degrees of revaluation that are most important here (as compared to absolute values).

Further, based on the distribution of dwelling values, six socioeconomic sectors are identified. This facilitates sectoral analyses, in addition to treating the study area as a whole. The importance of recognizing the existence of such an arrangement when examining socioeconomic patterns is supported by Murdie's (1969) examination of the factorial ecology of Toronto, and reflects Hoyt's (1939) insights into the structure of cities. This dual perspective affords greater penetration into the nature and significance of the socioeconomic reorganization.

The model presented here examines the potential intraurban income distribution of households when they are faced with suburban land consumption restrictions. Thus, two fundamental constraints confine the possibilities open to the consumer. The first limitation is the level of income which confines the amount of housing, goods, services and movement expenses that can be financially borne. The second restriction is the existence of site space controls on current and recent housing developments (contrary to the assumptions of the older models mentioned above).

This new model simplifies the residential selection process to that of choosing the desired amount of space, and the desired relative location. These choices are made in light of the knowledge that goods and services must also be purchased, and that the total expenditures are limited by the household income. The amount of residential space is not evenly distributed throughout the metropolitan center, nor is the resultant commuting cost. This creates the ensuing tradeoff between the amount of space attained, and the cost of commuting that results from the relative location selected. In the standard urban land rent models, the availability of land increases with distance from the core, as do the related commuting costs. These assumptions do not allow for: the location of employment, goods, services, etc. outside of the core; the historical continuance of large lot areas within the city; or the presence of smaller residential space at or near the periphery (such as would be the consequence of planning restrictions).

The budget equation-based model presented here combines a quantity of space, a measure of accessibility (i.e. commuting) and an amount of goods and services. These represent the total costs to the household and the total expenditure of its income. This structure is fundamental to much of the land rent-related literature such as the works of Alonso (1960, 1964), Muth (1969), Gera and Kuhn (1977) and Thrall (1987). Based on actual space and accessibility data, the theoretical income necessary to live at a certain location is predicted. The space data are based on the relative measure of site area, floor area or a composite area (representing a combined value of site and floor values) of the location in question. The accessibility information for that locale is derived from an employment potential measure or from its distance from the core. The total goods and services purchased are combined into a composite good variable, and held proportionally constant.

Predicted relative numbers (and their distributions) are compared to the actual relative amounts (and their spatial pattern) mentioned earlier. These values and distributions are compared through a variety of descriptive and statistical methods. Simple linear regressions are executed on all combinations of variable pairs to reveal dominant relationships. Weighted least squares multiple regressions are performed to assess the various iterations of the model. These are also completed for the different sectors. Based on the results from weighted least squares procedure, the best variable combinations are used to derive three sets of predicted values. Each set is based on a different space measure i.e. site area, floor area or composite area. The results are mapped and each map is compared to the spatial distribution and relative level of the actual dwelling values. Lastly, cluster analyses are used to provide insight into the primary relationship between relative lot sizes and their revaluation and accessibility.

Through separate iterations of the model, the contributory significance of each of the different measures is considered (i.e. site versus floor versus composite, distance versus employment potential, etc.). Further, the predictive and representative qualities of the model are evaluated, and the fundamental principle of the effect of lot size constraints and relative accessibility is assessed.

Generally, the model performs well. The goodness of fit is improved in the higher socioeconomic sectors, compared to the results gained for the full study area. The spatial distributions of the predicted values strongly correspond to that for the actual values. Site area and composite area prove to be the most contributory. The outcomes of the cluster analyses support the elemental logic or premise of the model.

The next section, Chapter Two, examines pertinent literature with regard to explaining urban residential patterns. For the immediate purposes of the dissertation, this falls mainly into two categories: one examining gentrification and the inner city, and the other reviewing the development of residential location theory. From this base, the requirements of the new model are established.

Chapter Three defines the assumptions, logical progression and derivation of the "centripetal shift" model. Chapter Four provides an historical outline of the morphology and physiology of the case study. Emphases are placed on the evolution of the residential structure and the contributions of planning to the urban form. The chapter following explains the method of the study: variable measurement and the empirical testing procedure are described.

Chapters Six through Nine detail the theoretical and empirical analyses and results. The first of these four sections explores the relationships between the theoretical components of the model: residential space, accessibility, and income. The variables and the potential correlations between them are evaluated with consideration given to the new parameters of the model. The previously standard relationship between two variables, i.e. that propounded in such models as the works of Alonso (1964) and Muth (1969), is contrasted with the proposed effects caused by potential space restrictions and polycentricity. Land price and quantity (two attributes of residential space) are examined in light of changes in accessibility, and the effect of access on income is discussed. This theoretical contribution provides the foundations for the assessment of the model's applicability to the case study of Metropolitan Toronto.

Chapter Seven is comprised of the description and assessment of the trends in estimated dwelling market values, and the identification of the sectors. Values for 1961, 1971, 1981 and 1986 are included, as are the percent changes between different time periods. Spatial configurations for the years listed are described and compared. Changes and consistencies between consecutive maps are assessed to provide an indication of spatial and temporal trends. To facilitate comparison, actual values are converted to a relative scale. This scale is consistent for all maps of dwelling value and change. Evaluation of the patterns provides insight into the changing intraurban distribution of socioeconomic groups, and helps evaluate the notion of a revaluation and centripetal income shift. Based on the patterns of dwelling value over the study period and supported by previous research, six sectors are identified. This permits the statistical analyses to be performed by sector, in addition to treating the study area as an entity, providing greater insight into the relevance and applicability of the model.

The next section contains the regression analyses performed on the study area as a whole and by sector. These include simple linear regression, multiple regression and weighted least squares multiple regression for the full study region. Sectoral analysis is performed using the latter method. The regression applications permit the identification of relevant relationships between variables, and the measurement of the goodness of fit for the different variable combinations for the separate iterations of the model. The testing of the separate sectors (in addition to the full study area) provides greater insight into any spatial and/or socioeconomic group variation in the model's reliability.

Chapter Nine holds the spatial patterns of the predicted values based on site area, floor area and composite area. Assessments of the predicted value distributions versus the 1986 actual dwelling value distribution are performed. These descriptive evaluations provide greater insight into spatial correlations between predicted and actual relative values than the above tests. The cluster analyses, incorporating a fundamental premise of the dissertation, are also included in this section. These analyses help examine the revaluation of space for those blocks having similar levels of accessibility. The final chapter contains the conclusions.

CHAPTER 2:

EXPLANATIONS OF URBAN RESIDENTIAL PATTERNS

2.1 Introduction

The stereotypical urban structure has for centuries been one of progressively declining densities towards the periphery, and, within sectors, of an increasingly higher socioeconomic composition. However, in some post war central cities and their older suburbs a different form of residential structure has emerged: concentrations of increasing economic status and structural upgrading are materializing.

During the late 1960s and 1970s a substantial number of Western cities experienced the phenomenon known as gentrification. This was originally described by Glass (1964: xviii) in her study of London:

> One by one, many of the working class quarters of London have been invaded by the middle-class-upper.... Once this process of 'gentrification' starts in a district it goes on rapidly until all or most of the original working class occupiers are displaced and the whole social character of the district is changed.

One result of gentrification is the displacement of the poorer groups because of their weaker position in the housing market. Previously they were concentrated in the inner city because of their restricted buying power; today, in an increasing number of cities and in an increasing number of areas within them, the poor are now being displaced from their neighbourhoods for the same monetary reason.

Ley (1981: 144), in his study of inner city revitalization in Vancouver, notes:

> The market, which has failed the disadvantaged in the industrial inner city through underinvestment, is penalizing the same group in the postindustrial city through overinvestment.

Investment and reinvestment, however, is not confined to the inner city. Traditional explanations of residential location suggest that higher income groups reside at or toward the periphery (Burgess, 1925; Hoyt, 1939; Clark, 1951; Alonso, 1960, 1964; Muth, 1961, 1969), often as a consequence of the greater valuation of space over access. However as mentioned previously, suburban development in most cities in Canada (and elsewhere) takes place within a planned environment, and is usually exposed to a number of constraints on lower density development.

It is suggested here that these space restrictions have contributed to an inward socioeconomic restructuring that is not confined to the inner city, and includes the older suburbs as well. Thus, the question of reinvestment (and its resulting displacement) is a question of the spatial overconcentration of demand and capital (Weiler, 1978).

Related literature and research tends to follow two streams. The first is the study of gentrification and inner city structure. The second lies in the field of residential location and land rent theory.

2.2 Gentrification and the Inner City

Research dealing with intraurban reinvestment, revitalization, gentrification and the numerous other labels[1] applied to this changing composition has concentrated on the inner city. This is the area that is most visibly affected, although the processes involved are not geographically limited to this space.

The bulk of the gentrification literature can be separated based on two distinct approaches. The first is characterized by a highly empirical approach, containing descriptive studies of an individual city or single neighbourhood, or occasionally a comparison of different studies. Most are not cumulative and vary in method and perspective. A number of review articles have attempted to coalesce these (see for example Hamnett, 1984; Rose, 1984). The second approach is comprised of attempted explanations of the process and of the underlying causes of gentrification (Smith and Williams, 1986; Gale, 1984; Smith 1979, 1982; Laska and Spain, 1980; Hamnett and Williams, 1979).

---

[1] Various terms have been applied to the socioeconomic restructuring that is taking place in central cities, such as 'gentrification' (Glass, 1964), 'inner city revitalization' (Ley, 1981), 'central city revival' (Lipton, 1977), 'neighbourhood reinvestment' (Clay, 1980), and simply 'revitalization' (Berry, 1980). While these are not fully synonymous, there are considerable similarities. For the most part, the term 'gentrification' is most often used and refers to structural renovation and socioeconomic upgrading. 'Revitalization', likely the broadest term, includes redevelopment in its terms of reference.

Within the first approach, explanations of gentrification tend to focus on four dominant themes. No single explanation is sufficient, but in combination the four are suggested to have important implications. These are labelled as: demographic change, lifestyle shifts and urban amenities, economic base and occupational structure, and housing market dynamics.

2.2.1 Demographic Change:

This is considered to be one of the key ingredients underlying gentrification (Berry, 1980; Clay, 1980; Long, 1980). The housing demand surge (and rapid price inflation) during the 1970s is attributed in part to the postwar baby boom and its resultant increase in the 25-30 year old age group (Greenspan, 1978; Grebler and Mittelbach, 1979).

A related factor is the decline in household size. This is a product of a variety of influences, including declining family size, increased single or unrelated households, more women in the workforce, higher divorce rates and deferred childbearing. The implications for the housing market include greater demand for less expensive, higher density accommodation.

2.2.2 Lifestyle Shifts and Urban Amenities:

Changes in demographic structure are associated with shifting lifestyle preferences. These, in turn, are consequential for residential preferences. Decreasing family size and deferred childbearing have altered the perceived housing needs (Lipton, 1977). Coupled with the rise in the proportion of women in the work force and the increase in two income families, greater accessibility may be given a higher priority (Berry, 1980).

The contribution of accessibility to the selection of a more central location was recognized much earlier by Alonso (1964). Two important points here are that the assumption of the space/accessibility tradeoff (more of one implies less of the other) is not necessarily valid today (Code and Bailey, 1989), and the higher priority given to accessibility may incorrectly imply a back to the city movement of people (Gale, 1979; Smith, 1979).

Further, two income households may have a larger disposable income component. This, according to Ley (1983), will contribute to the growing importance of certain urban amenities such as environment and culture. However, it remains to be seen if all cities with improved cultural and environmental aesthetics experience similar levels of gentrification. Recent civic improvements in Detroit have not stimulated much additional investment or resulted in the levels of change seen in Baltimore, for example.

2.2.3 Economic Base and Occupational Structure:

The changing employment structure of the household relates to the occupational shift resulting from "the presence of a 'postindustrial' metropolitan economy, oriented toward advanced services and a white collar employment structure" (Ley, 1986: 524). Increases in inner city household status are shown to be associated with a tertiary- and quaternary-dominated economic base (Gale, 1984; Lipton, 1977).

2.2.4 Housing Market Dynamics:

The relationship between the metropolitan housing market and gentrification has been expounded on by Berry (1980) and others. The basic premise relates to the rates of new housing production and of household formation. New construction and rehabilitation are inversely related: when new supply is less than demand, inner city locations are revalued. Berry (1980: 23) also relates this to employment structure:

> An implication is that significant revitalization may be limited to the metropolitan areas of postindustrial management, control and information processing activities.

This argument, similar to the demographic change logic (and the ensuing lifestyle preferences) may suggest that inner city gentrification or revitalization is cyclical and thus temporary. Further, if it is possible to meld these emphases, the changes have created relatively affluent, inner city-employed households with an increased preference for accessibility, clustered in large cities with service and office employment concentrations.

These changing preferences, and thus changing demand, underscore the importance of understanding the housing market and its changing role and structure, yet provide little insight. Hamnett (1984: 311) argues:

> Although the changing demographic and employment structure of the population are frequently employed as necessary underpinning for arguments relating to shifts in lifestyle preference they do not, of themselves, emphasize consumer preference. Nor does Berry's (1980) analysis of the changing balance between new construction and rehabilitation.

Thus, the causal relationships involved in the socioeconomic restructuring of the central city (and the older suburbs) via the modifying function and structure of the housing market still need to be identified.

2.2.5 The Rent Gap Hypothesis:

The second approach stresses supply criteria (Smith 1979, 1982). This explanation of gentrification is based on the existence of a 'rent gap', which Smith (1979: 545) defines as "...the disparity between the potential ground rent level and the actual ground rent capitalized under the present land use".

The rent gap hypothesis has received considerable scrutiny.

As Clark (1987) points out, the underlying basis of this approach is a derivative of both neoclassical and Marxian land rent theory, put in a Marxian perspective by Smith. Its major strength lies in its theoretical attempt to develop a systematic explanation of gentrification; its major weakness is its narrow focus on the land and housing markets, to the exclusion of all other potential factors (Badcock, 1989; Clark, 1987; Ley, 1986; Hamnett, 1984). This exclusion can result in the omission of important, but tangential, considerations: the typical Canadian city, for example, has been subjected to a variety of planning policies and directives, with limited foresight of reactions from existing market conditions. In effect, planning policies are often circumscribed by their own restricted "field of vision" as well.

Further debates between Bourassa (1990) and Badcock (1990), and in particular Ley (1987) and Smith (1987) point out that the appropriate conditions for gentrification can not be separated from the more widespread process of suburban growth. This implies a relationship of complementarity in urban change. In accordance, Clark (1987: 86) summarizes:

> Looking now with a broader view towards an understanding of urban change, land rent theory should properly be considered illuminative of one aspect of urban change. Though knowledge of this aspect is vital to understanding processes of urban change in specific places, and though the theory consists of statements of very general nature, it should not be construed that any land rent theory can provide the makings of a complete

> description or explanation of urban change. Suburbanization, urban renewal and gentrification are complex processes, and there is therefore a wide spectrum of perspectives raising different assertions made in terms of different concepts.

Clark's summation, the substantial component of Smith's (1979, 1982) approach being rooted in land rent theory and the attention it has received all point to the potential significance of residential location and land rent theory in explaining in part the socioeconomic restructuring of the city.

2.3 The Development of Residential Location Theory

Residential location theory evolved from its roots in agricultural land rent differentials. Its application to an urban context was achieved in early economic theory, and refined to consider the residential sector more explicitly through modern urban-economics and spatial interaction models. Recent theoretical developments have attempted to include more "real world" attributes with varying degrees of success.

2.3.1 Early Economic Theory:

The concept of interchangeability between costs associated with the use of a certain site and transportation expenses arising from its relative location has been an underlying tenet in land rent theory since the monumental work of Von Thünen (1826).

Early twentieth century urban rent analysts, such as Hurd (1903), Haig (1926) and Hoyt (1939), have had some impact on urban economics through their application of the previous theory of agricultural land use to land use in cities. Each approach has uniquely contributed to land rent theory, but all are circumscribed in their advancement of residential location analysis.

Hurd (1903) emphasizes the role of competitive bidding in determining the distribution of land uses, but this is not extended to the allocation of residential land value (purported to be the social class of the household and neighbourhood). Transportation expense is labelled as secondary to social factors.

Accessibility and site rent are central to Haig's (1926) argument. The contention loses strength when applied to the residential context in that site size is not a factor and location is determined through weighing the desired degree of accessibility and the costs of friction. Site rent can be logically reduced by consuming a smaller site at the same location. Haig's argument would result in all households being located near the center of the city at high densities.

Hoyt (1939) bridges land economics and the research of urban sociologists by demonstrating the influence of socioeconomic status on the residential spatial structure of American cities. The resulting description of radial sectors critiques the concentric zone format (based on social stratification) put forth earlier by the ecologist Burgess (1925). Both models are fundamentally descriptive constructs of existing patterns, albeit *post facto*. Inductive approaches are used to develop empirically derived hypotheses without the theoretical framework evident in previous urban rent analyses.

2.3.2 Modern Economic Theory:

Possibly the best theoretically developed approach to residential location extends from microeconomics (Bourne, 1981). Following on the efforts of Hoover and Vernon (1959), residential location theory was formally stated in the works of Alonso (1960, 1964), Muth (1961, 1969) and Wingo (1961). Alonso's model is labelled as seminal (Richardson, 1977; Ball, 1985) because it extends urban rent theory through the development of the bid rent function and is based on the analysis of household utility.

The partial equilibrium model developed by Alonso (1964) examines residential location (although the model is extended to include the urban firm with appropriate adjustments in parameters) through reconciling the concentric zone model of urban land rent with utility maximization by households (and profit maximization by firms). The demand surface for the household is derived through the manipulation of a budget equation containing all of the choices open the consumer with a set income. Alonso transforms the demand surface into a bid rent function (to allow a solution of individual and market equilibrium) which combines the indifference surface approach with land price consideration. The bid rent function is defined as the set of land rents the individual will pay at various distances from the core while maintaining a constant level of satisfaction[2].

In effect, Alonso's model accomplishes the combination of utility, land, distance, the composite good and money, and presents it in two dimensions: land cost and distance. The equilibrium location can be determined if the actual price structure is superimposed on a set of bid rent curves: it is the point where the price structure and the bid rent curve are tangent. Thus, a market-based optimal distribution of location prices and an equilibrium pattern for all individuals based on utility maximization are achieved.

Muth's (1969) general equilibrium model contains some variations in the basic framework discussed above. There are fundamental differences between Muth's work (1969) and that of Alonso's (1964). Muth assumes the presence of polycentric workplaces without disruption of the results of his model.

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[2] The bid rent function was originally referred to as the bid price curve or function. It differs from the indifference curves which compare the combinations of goods without consideration of prices (see Alonso, 1964).

This is due in part, however, to the high level of abstraction and the use of distance of the residence from the center (similar to Alonso) as his accessibility subrogate. Muth also assumes a negative wage gradient. In contrast, Alonso provides discussion of various competing and complementary center scenarios, but does not incorporate these. Instead, the different possibilities are considered for "future research". Muth does not consider transportation costs as being based strictly on distance, but includes a value of travel time that varies with income. Further, his treatment of housing supply and demand includes both land and dwelling (versus land only in Alonso's model) permitting substitution of interior and exterior space, and declines in dwelling quality with age. Lot sizes and services may vary without regard to relative location because urban land is considered heterogeneous. Thus, variety in housing prices and land values are functions of more than just distance from the core.

Both models fail to adequately incorporate the effect of a polycentric urban form on household accessibility, or the potential theoretical reorganization resulting from density constraints occurring at the periphery. Alonso's consideration of different bipolar structures leads in the appropriate direction, but it remains at the level of "possible applications" or "future research".

The third contribution to the standard framework of residential location, by Wingo (1961), differs in that a complex transportation function is applied and the utility function is not implemented. Rents and transportation costs are viewed as complementary and their sum is equal to a constant. This constant is equal to the transportation expenditure to the most distant residential location; rent at the urban boundary is assumed to be zero. The resident will spend the same amount on rent plus transport costs regardless of location. However, the preference for land and accessibility are not directly related; complementarity is required to determine land cost at a certain location. This restriction weakens the model compared to the use of utility maximization. Wingo's theory is limited, fundamentally, to exploring the effect of changes in the transportation system on urban land use. Its strength lies in the discussion of congestion and the value of travel time. His analysis shows that various preferences for accessibility create a concentric zone pattern of resident al land use.

The fundamental differences between the works of Wingo (1961) and Alonso (1964) include: the separation of accessibility (monetary costs of commuting time) and space (quantity of land) by Wingo, while Alonso allows preferences for accessibility and space to be interrelated; and transportation costs and rent are complementary in Wingo's analysis, while Alonso keeps these two items distinct from budget considerations until they are regarded in terms of marginal rates of substitution and costs (Alonso, 1964).

One additional paper from this time period (M. Beckmann, 1969; first circulated in mimeographed form in 1957) deserves mention. Beckmann's model examines residential land values and considers lot size to be a key variable. It arrives at a market equilibrium for rents and densities such that rich households reside at the urban periphery, but suffers from very restrictive assumptions and the same limitations discussed with regard to the works of Alonso and Muth.

2.3.3 Spatial Interaction Models:

The conceptual framework of this type of model is one of social physics and not economics. Following the work of Lowry (1964), Senior and Wilson (1974), Wilson (1974) and others, aggregated and disaggregated residential location models are extended to include: supply and demand of housing stock by type, household income class, and dependent working and nonworking household members[3]. In the monocentric city, employment is exogenous and residential location is selected in relation to it. In the polycentric city it is not clear

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[3] Generally, the applicability of the gravity model type of approach to rational modelling of utility maximization is limited. For further discussion of spatial interaction models of residential location see M. Senior, "Approaches to Residential Modelling 1: Urban Ecological and Spatial Interaction Models", Environment and Planning, 1973, 5: 165-197.

whether the household seeks its residential site in response to a given job location or vice versa: the causal factors will differ. Another weakness (evident in the Lowry model, for example) involves the constraint preventing residential densities from exceeding a maximum. This is allowed to vary from zone to zone, reflective of city structure, but the constraint provides no indication of the influence of higher densities that are lower than the maximum on residential site choice.

These techniques are rejected in the work of Beesley and Dalvi (1974) and later by Gera and Kuhn (1977) who construct two separate models to explain the journey to work trip length. The first model follows on the Alonso-Muth framework and assumes a fixed employment location. The second model takes a different approach and considers the residential location as fixed[4].

It is the first model that is of interest here. Within the

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[4] The second model assumes a positive relationship between income and distance from the home (subject to an upper limit): the optimal job location occurs when the marginal increases in income and commuting costs are equal. Beesley and Dalvi (1974) assume a wage gradient exists (similar to a rent gradient) where wages are greatest at the core and reach lower peaks at secondary employment nodes. This has received little empirical support. Gera and Kuhn (1977) attempt to incorporate this surface through the use of a number of proxies. Earnings are examined directly and an earnings potential is calculated to provide an indication of wage level and closeness of other employment zones. This potential is measured as a subrogate of job search costs i.e. high potential indicates low search costs.

aforementioned framework, individuals simultaneously choose their residential location, the quantity of housing and its quality. This is examined with three variables: structural type, indicative of residential density (single detached dwellings only are considered, although possible substitution of types is noted); number of bedrooms, reflective of housing quantity or interior size (dwellings with three or more); and age of the structure, representing dwelling quality. Several limitations are apparent. No consideration is given to the space restrictions evident in newer developments: a new, small single detached three bedroom bungalow on a small lot would rate higher than an older large home on an estate lot. The greatest proportion of the housing stock has been constructed within the last three decades[5]: the usefulness of age as a subrogate for quality is limited.

2.3.4 Alternatives and Recent Models:

Desirable progress in urban economics would merge different approaches: economic theory, the use of empirical data (as in econometrics), and replication of urban-economic behaviour (as in simulation models) (Richardson, 1977). This direction is taken in the NBER Simulation Model (Ingram et al., 1972). It focuses on housing market behaviour, detailing a supply sector, a demand sector and a price formation sector combined

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[5] For statistical support see: CMHC, Canadian Housing Statistics, Ottawa: CMHC, 1970-1987; and Statistics Canada, Population and Housing Characteristics: Toronto, Census Tracts, Ottawa: Statistics Canada, 1981.

recursively to replicate market operations for each time period. A number of limitations exist with regard to the factors of the location decision. Greater empirical measurement of socioeconomic status and residential density are needed to reflect changing conditions. In the model, households select type of dwelling and then location, restricting the potential tradeoff of space for accessibility. Lastly, defining employment exogenously constrains causal factors inherent in simultaneous selection.

A recent contribution to the development of residential location theory is the Consumption Theory of Land Rent put forth by Thrall (1987). Conceptually, two of the scenarios are of concern here. These deal with planning or institutional tools that (i) limit the spatial extent of a city by imposing a restriction on its diameter, and (ii) require a higher population density or higher land rent.

The first arrangement is meant to reflect "Anglo-Canadian cities... that are circumscribed by greenbelts" (Thrall, 1987: 154). The basic notion is that Provincial government zoning will radially constrain urban expansion, limiting the city to a specific spatial size. This leads to decreased household utility and either (a) increased land rents and densities or (b) decreased population.

The second schema involves a central authority determining population densities and land rents. Thrall suggests this is most applicable to centrally planned non-market economies, but that it may also relate to capitalist countries which have temporary rent control laws (usually during wars or periods of unusually high inflation) or theoretically restrictive zoning laws. However, he suggests that in reality, zoning laws are little more than an indicator of the land use that can and does pay the most for that land, and "...when this changes, so does the zoning" (Thrall, 1987: 155). Constraining land consumption leads to the typical welfare surface, with the exception that the level of utility is uniformly reduced.

While the notions of a radially constrained city and restricted land consumption through increased population density are expounded theoretically, the underlying assumptions reduce its applicability to the desired representation. In Thrall's "Consumption Theory of Land Rent", accessibility is directly related to distance from the core, as a monocentric city for shopping and work is assumed. This is complicated at one point with increased access transportation nodes, but the location of goods and employment remains the same. A maximum quantity of land (i.e. a lot size constraint) is introduced but this limit is applied to the full spatial extent of the city, disregarding the historical character of urban growth.

Conceptually, while the basic premises are pertinent, the scenarios are not applicable to the case study. First, Toronto (like most cities in Canada) does not have a greenbelt. New development is limited to varying degrees, and occasionally directed to desired areas rather than wholly restricted. This is often accomplished through the planning approval process and zoning. As such, it relates to the second point that zoning is effective and exclusive. Thirdly, albeit tangential to this study, Ontario has had rent control legislation in effect for approximately two decades. More importantly, the impact of restricting the nature of residential development (such as lot size constraints) at the periphery of the built up area (typical of recent construction in Canadian metropolises) is not considered.

2.4 Requirements of a New Model

In order to create a model of residential location that is more representative of contemporary Canadian metropolitan centers than the urban base proposed by most of the preceding theories, certain characteristics must be incorporated. Building on the limitations evident (or acknowledged) in the approaches discussed and cognizant of current trends in residential development, aspects that need to be incorporated include:

- multiple employment, goods and service nodes;
- increasingly intensive use of residential land at the edge of the built up area;

- possible suburban land consumption constraints;
- accessibility measures that evaluate the polycentricity of various attractions;
- transportation expenditures that weight relative accessibility, instead of distance from the core;
- alternative measures of the quantity of the housing bundle indicative of different aspects of the composite space consumed; and
- per unit residential cost that reflects relative accessibility instead of distance from the urban center.

These points are expounded upon in the following section and embodied in the "centripetal shift" model of residential location.

CHAPTER 3:

THE CENTRIPETAL SHIFT MODEL OF RESIDENTIAL LOCATION

3.1 Introduction

The standard urban and economic models argue that higher socioeconomic groups reside at the periphery of the urban area to satisfy their desire for low density housing and more land. This is depicted in the concentric ring model (Burgess, 1925) and underlies Hoyt's (1939) argument concerning the growth of high rent areas. It is basic to the Alonso-Muth type of model presuming a negative rent gradient and the transportation-based theoretical analysis put forth by Wingo (1961).

This is in contrast to the intensive use of residential land experienced in many Canadian suburbs. The increased utilization is reflected in the increased mix of dwelling types (Bailey, 1981), the limited supply of appropriate vacant land (Metropolitan Toronto Planning Department, 1987b) and the planning guidelines for increased densities (Metropolitan Toronto Planning Department, 1978, 1987b, 1990). New development is taking place on smaller lots, reflective of site size restrictions, and the availability of large residential plots is substantially diminished.

Pompilii (1981) studied the change in lot sizes in London, Ontario. The average single detached lot decreased from 0.28 acre (1942-1946) to 0.15 acre (1977), and the semi detached lot dropped from 0.21 acre (1957-1961) to 0.16 acre (1977). Similarly, new housing development in Metropolitan Toronto often takes place on narrow lots (35 feet or less wide) and about half of the recent construction outside Metro has occurred on lots narrower than 50 feet (Metropolitan Toronto Planning Department, 1987b). Additionally, the residential densities of registered plans of subdivision in Metropolitan Toronto have generally increased since 1971. Density calculations for 1977 to 1984 document a low of 26 units/hectare (10 units/acre) in 1977 to a high of 37 units/hectare (15 units/acre) in 1984, despite the fact that half of the units in 1984 were single detached houses (Metropolitan Toronto Planning Department, 1987b).

The increasing intensity of residential land use adds to its proportion of the total housing price, as the division of land into smaller lots in turn contributes increased lot prices. Greenspan (1978) has documented that, by 1976, lot cost accounted for half of the total housing price in Toronto[1]. The continued pressures on land for development and the growing volume of planning directives to decrease lot size (to help raise residential densities) have exacerbated this problem.

[1] Between 1972 and 1975, nominal lot prices in Toronto increased by 104 percent. During this period of inflation, this was fifty percent more than general consumer prices (Greenspan, 1978).

One common assumption in the classical and newer models is the availability of more land and any type and size of housing (i.e. larger lots and bigger homes representing better quality and higher income requirements) at the periphery. The implication of restricting suburban lot sizes conflicts with the assumptions of earlier models and has both theoretical and empirical implications for intraurban income distribution.

Older areas containing larger lots are subjected to a revaluation, and the importance of a more central or closer to work location increases as the tradeoff between more land at the periphery and higher commuting costs no longer exists. Large homes and lots located closer to the various employment nodes increase in value relative to the surrounding areas. The location of a home and lot near the core contributes to its revaluation as the importance of its accessibility and space outweigh the structure's age. Increments in the socioeconomic levels in central areas occur. The emerging urban form and the adjustment in location of households based on income drastically alters the organization of the city described and predicted by earlier models.

In explaining the residential location decision a common hypothesis in neoclassical economic theory is that a tradeoff takes place between the cost of a certain location and the transportation costs arising from its distance from other locations of importance[2]. A standard assumption is a monocentric city with employment and services available solely at the center. Residential location is derived from the consideration of distance travelled to work (less being better) and the quantity of land and housing (more being better and available only with increasing distance from the core). The greatest amount of growth takes place at the periphery of the built up area and is residential in nature (Hoyt, 1948; Adams, 1970; Berry and Horton, 1970; Yeates, 1975, 1980; Yeates and Garner, 1980; Simmons and Bourne, 1984).

Individuals or households (governed by their income) will try to maximize their utility through the tradeoff between the desirability of the residential site and their nearness to

[2] This is fundamental to the economic theory of J. Von Thünen (discussed in W. Alonso, Location and Land Use (Cambridge,Mass: Harvard University Press, 1964), E. Dunn, Jr., The Location of Agricultural Production (Gainesville: University of Florida Press, 1954) and W. Isard, Location and Space-Economy (New York: John Wiley & Sons, 1956). It was later applied to the pattern of residential location by E. Hoover and R. Vernon, The Anatomy of a Metropolis (Cambridge, Mass.: Harvard University Press, 1959), W. Alonso, "A Theory of the Urban Land Market", Papers and Proceedings of the Regional Science Association, 1960, 6: 149-157, and Location and Land Use (Cambridge, Mass.: Harvard University Press, 1964), R. Muth, Cities and Housing (Chicago: University of Chicago Press, 1969) and L. Wingo, Transportation and Urban Land (Washington: Resources for the Future, 1961). The concept of location and transportation cost is also incorporated into the new urban economic models (see H. Richardson, The New Urban Economics: and Alternatives (London: Pion, 1977)).

work[3]. The concept of utility is a standard approach used by economists to explain how consumers make rational choice decisions. Individuals or households are assumed to maximize their utility (or satisfaction) subject to constraints on their choice, the most obvious constraint being income. Their satisfaction is assumed to be a function of the amounts of different goods and services consumed (more being better than less). It is also assumed that if an individual has a small amount of good A and a large quantity of good B, a small increase in A will result in a greater increase in utility than a small gain in B[4]. Household income and land consumption increase with distance from the center, indicative of the desire for more land and the increased ability to pay (Alonso, 1964; Mills, 1967; and Muth, 1969).

This results in population density declining with distance from the core and the lowest density occurring at the periphery of the urban center (Clark, 1951; Berry, Simmons

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[3] Alonso (1964) and Wingo (1961) examine the utility function in terms of the "individual" and the "workers"; Muth (1969) treats this function as being for the "household". Their work has provided the framework for all recent economic models of residential location (Gera and Kuhn, 1977, p.18).

[4] This is the principle of diminishing marginal utility. The rate at which the consumer is willing to exchange good A for good B is called the marginal rate of substitution. For a fuller explanation see W. Alonso, Location and Land Use (Cambridge, Mass.: Harvard University Press, 1964, p.173-181), H. Richardson, The New Urban Economics: and Alternatives (London: Pion, 1977, p.26-30) or any standard economic textbook.

and Tennant, 1963; Newling, 1966; Berry and Horton, 1970; Muth, 1985). The correlation between income and land consumption is a basic premise: average lot size increases with household income, and both increase with distance from the core (Quigley, 1978; Bourne, 1981; Heilbrun, 1981). Land values rise with augmented total population and density (Thrall and Feather, 1987).

The standard model of urban form assumes that land value is a function of accessibility, but a monocentric city with a single employment nucleus is inappropriate for explaining the dominant metropolitan areas of current North America. Gera, Betcherman and Paproski (1978) show that for Toronto, various commuting flows are not destined for the central core and these constitute a significant portion of the overall journey to work pattern. These findings are supported by Coppack and Robins (1987) who prove that commuting from the suburban municipalities of Metropolitan Toronto (Etobicoke, North York and Scarborough) out into the census metropolitan area (CMA) almost doubled between 1971 and 1981. Further, interaction within and between the City of Toronto, the remainder of Metropolitan Toronto and the CMA has increased. While the stereotypical pattern of travel from suburb to core is still important, commuting is no longer simply inbound. Previous theoretical and empirical analyses have attempted to incorporate a polycentric city with residential location, with varying degrees of success (Muth, 1969; Evans, 1973;

Gera and Kuhn, 1977).

Further, planning decisions and public and private investment may alter accessibility due to concentration or decentralization - in either case, destinations may be affected. Subsequently, changes in accessibility patterns will likely affect the residential location decision. Studies of commuting trip durations for the twenty largest U.S. metropolitan areas have shown a paradoxical relationship between commuting time and traffic congestion (Gordon, Kumar and Richardson, 1989; Gordon, Richardson and Jun, 1991). While congestion may be increasing, the average commuting time for the auto commuter is generally decreasing. This may be due to the rational adjustment made by households and firms when faced by adverse changes in accessibility. Gordon, Richardson and Jun (1991: 418) note:

> ...commuters were making location adjustments (or benefitting from location adjustments by firms) to prevent the extra time costs of increasing congestion from having a significant impact on commuting averages. These adjustments might involve a change in residence or a change in work place, either to reduce the length of the work trip or to allow the use of less congested routes.

Thus, accessibility may be increasing in importance in the household's location decision.

A new model of residential location, presented below, examines the location behaviour of a population within a polycentric metropolitan area when the multicentered locations of employment, goods and services (factors in the degree of relative accessibility), and the effects of income and lot size restrictions are considered in the location decision. It predicts a centripetal reorganization of higher socioeconomic groups when a center is subjected to suburban land consumption constraints. This results in an income distribution pattern that contrasts existing theories of urban form, and helps explain the core convergent trends occurring in many Canadian cities. The budget equation-based model allows a household to select a location that best maximizes relative accessibility while minimizing density limitations, subject to budget and development constraints.

3.2 The Proposed Model

3.2.1 Assumptions:

1) An urban center is assumed with the locations of employment, goods and services being polycentric within a metropolitan area. Planning policies and the degree of polycentricity are external and unique to the context of the individual city.

2) Transportation costs are assumed to be a monotonically increasing function of distance and travel is possible in all directions. Monetary expense and the value of time are considered to be implicit in the transportation costs and the consumer is capable of calculating this cost regardless of the nature or purpose of the trip.

3) The consumer behaves rationally by maximizing utility subject to a budget constraint and has perfect knowledge.

4) Residential space is assumed not to be an inferior good. Each dwelling type is assumed to be available throughout the urban area and the price of a dwelling at a certain location reflects fully capitalized locational advantages.

5) Residential development may be subjected to a constraint restricting lot sizes.

The first assumption contrasts the theoretical work of Alonso (1964) who assumes a monocentric city in the creation of his model[5]. Muth (1969) addresses the effect of non-central workplaces on land uses, but at a high level of abstraction. In his empirical testing accessibility is measured in terms of the distance of residential location from the core. Kain (1964) examines multiple workplaces with regard to the tradeoff between housing consumption and the work trip, but these employment centers have no affect on location rents. The assumption of employment locations being polycentric is put forth by Gera and Kuhn (1977) in their residential location model and supported in this work.

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[5] Alonso (1964) examines various bipolar urban forms in the extended discussion of his model. These schemata are identified and suggested as worthy of future research, but are not explicitly incorporated into the framework of the model.

The assumption that transportation costs are a monotonically increasing function of distance is fundamental to the basic modern economic theory of residential location developed by Alonso (1964), Wingo (1961) and Muth (1969). Gera and Kuhn (1977) note that these works provide a common theoretical framework for all recent economic models of residential location. They further contend that distance is an acceptable proxy for total transportation costs including time costs and modal choice. The assumption used here follows on their logical progression.

With regard to the third supposition, it is postulated that the actions of the consumers are affected by individual and household socioeconomic characteristics and these are considered to be implicitly incorporated in their utility functions.

The recognition of different dwelling types and locational advantages contrasts Alonso's (1964) model. He assumes that land only is marketed, without having its character or value affected by any existing structures, quantity is not restricted and all land is of equal quality; thus, only land quantity is variable with income. Muth (1969) assumed that land and housing are marketed together, and that a tradeoff could take place between quantity and quality i.e. a household could consume more housing by accepting a lower quality.

It is presumed here that different dwelling types do exist, to reflect the increased mix of structural types occurring in suburban developments. It is also postulated that land quality varies and that locational advantages, whether indicative of such attributes as ravine lots, larger sites, nearness to open space or other neighbourhood amenities, are reflected in the housing cost.

The last assumption embodies the planning and development constraints present in many Canadian metropolitan areas which restrict lot sizes. This consideration departs from earlier models which assume that land availability increases with distance from the center (such as the Alonso-Muth framework).

3.2.2 Structure:

The model, fundamentally an extension of Alonso-Muth, enables consumers to select their residential location and housing characteristics through utility maximization subject to budget and other constraints. The model tests the proposition that such behaviour can explain the intraurban income distribution pattern.

In the classical economic model, income is the primary determinant of household location. It can be spent or saved in a myriad of ways; this has been simplified to the components of a housing expenditure, a transportation expenditure and a composite expenditure reflecting all other possibilities (including savings)[6]. This can be expressed as:

household income	=	housing expenditure	+	transportation expenditure	+	composite expenditure

It is assumed that each household will attempt to obtain the best possible living conditions it can afford. In accordance with residential location models such as the Alonso-Muth framework, a household may trade a more centralized location (i.e. better accessibility and lower transportation expenditure) for more or better housing and/or goods and services. The residential location choice involves maximizing household utility based on the function:

$$u = u(g, q, d) \qquad (1)$$

where g: amount of the composite good consumed
q: quantity of housing
d: distance between the center of the city and the household's location.

This is subject to the budget constraint[7]:

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[6] This simplification is fundamental to the basic modern economic theory of residential location and the new urban-economic theory.

[7] For a detailed explanation of the budget equation and the derivation of utility maximization see W. Alonso, Location and Land Use (Cambridge, Mass.: Harvard University Press, 1964).

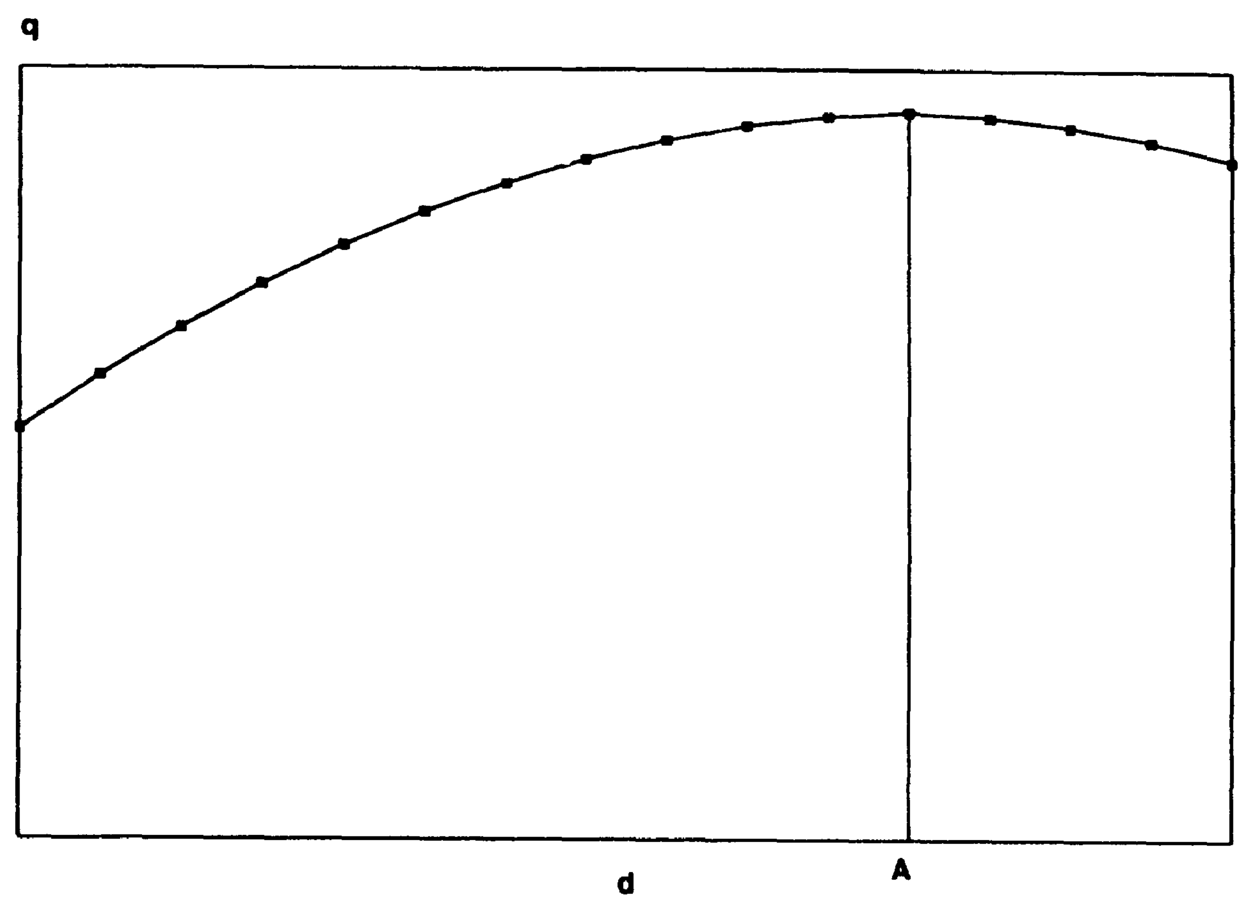
$$y = p_g g + h(d)q + r(d) \qquad (2)$$

where y: household income
p_g: index price of the composite good
g: quantity of the composite good
h: per unit housing price at distance d
q: quantity of housing consumed
r: commuting costs to distance d
d: distance from the urban center

In classical theory, residential location can be determined through the relation of land, distance from the center and the composite good. Alonso (1964) explained that the poor lived near the center of the city and the rich located in the suburban areas even though, paradoxically, land at the center was much more expensive, because the poor have steeper bid rent curves. This stems from commuting costs and the amount of land consumed. While the poor could better afford the cheaper land at the edge of the city, the cost of commuting restricted their ability to live there, forcing them to reside on a much smaller amount of expensive land near the core. The rich could afford any location, but presuming more land is more satisfying than less, could trade the cost and bother of commuting with the purchase of more space because of its per unit price declining with distance from the urban center.

This relationship can be shown by examining the locus of opportunities between land quantity, q, and distance, d, when the composite good is held constant (Figure 3.1). The

Figure 3.1: Locus of Opportunities
Between q and d When g Is Held Constant



after Alonso (1964)

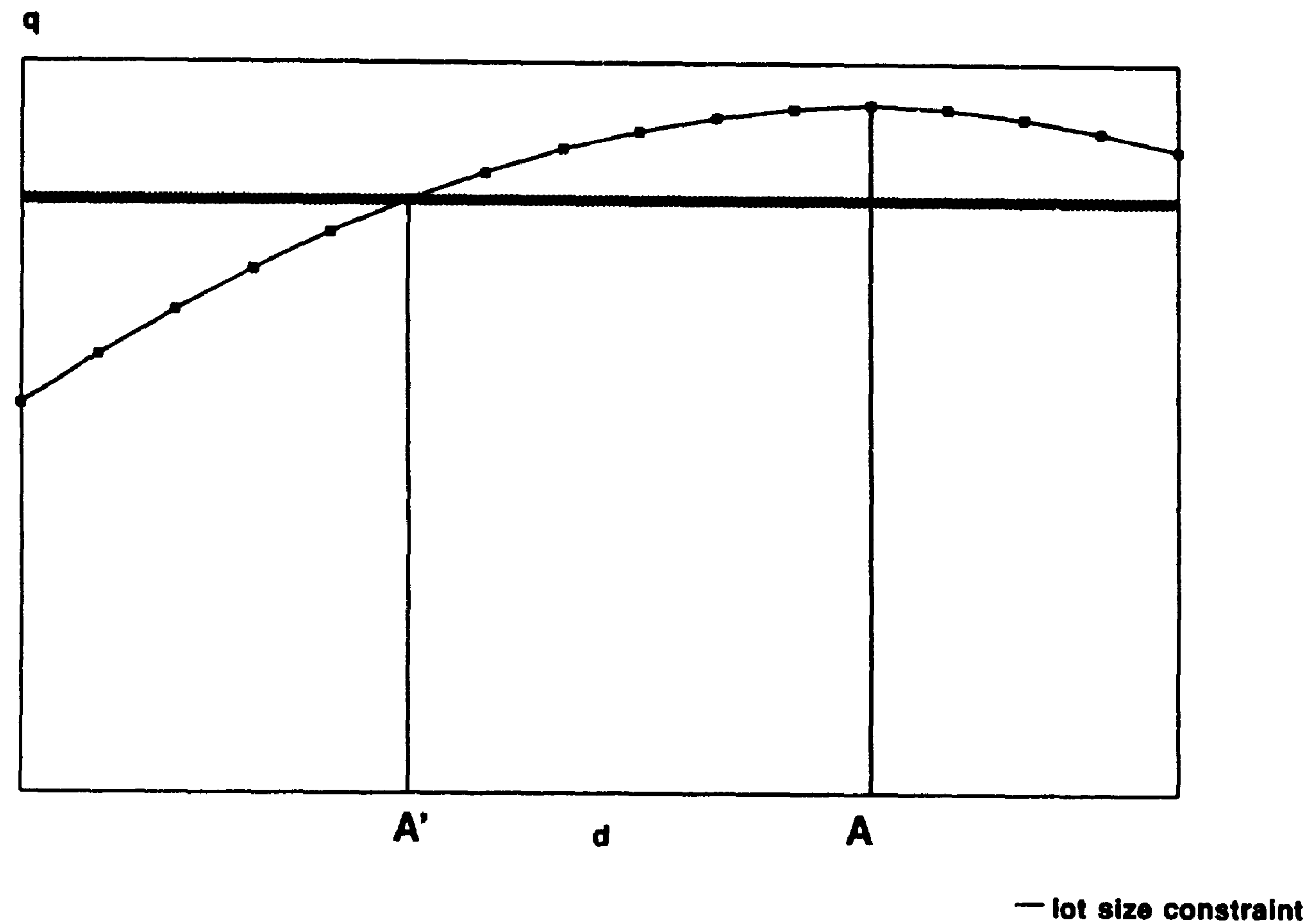
relationships of the three variables g, q and d create a three dimensional surface representing the simultaneous tradeoffs between location, land quantity and commuting expense a consumer can make when selecting a site. Alonso (1964) labels this surface the locus of opportunities. This is most easily described by holding one variable constant and observing the relationship between the other two.

Figure 3.1 indicates that while the price of land decreases with increasing distance from the core, commuting costs increase with distance eventually offsetting the declining land cost. The quantity of land rises with distance to the location A, where marginal gains in commuting costs equal the savings obtained from decreasing land price, and surpass them with distance thereafter.

Restricting the amount of land that can be purchased forces a revaluation of location by higher socioeconomic groups who would have located farther away from the core, because no tradeoff for the growing inconvenience of commuting with increased distance exists (Figure 3.2). This results in their movement from A to A′ and the subsequent increase in bidding for that location.

The result of a land constraint can be seen more easily by examining the components of the budget equation. The effect on the required income, y, and distance from the center

Figure 3.2: Locus of Opportunities
When Lot Size is Restricted



caused by varying land quantity, q, is shown in Figure 3.3. This is based on the data listed in Tables 3.1 and 3.2. In Table 3.1 commuting costs and land quantity increase by ten percent each per unit distance while land prices decrease by ten percent per unit distance. The quantity and price of the composite good are held constant. The income required at each location from the core is calculated. Table 3.2 sets identical conditions to the first scenario except that the quantity of land is held constant at ten units.

The effect of restricting lot size is dramatic. From the point of restriction the required income level drops significantly with distance, whereas in the example permitting land quantity to increase the level slowly rises. Thus, when the marginal savings of decreasing land price just surpass the marginal gains in commuting costs, locations of higher socioeconomic groups extend from the core. When no additional land is gained with distance, the richer households will bid for the closer locations.

In the classic example, the older suburbs surrounding the city contained homes built on large lots. As time progressed, a newer suburban ring was constructed beyond this area with bigger homes on bigger lots. The result is the situation first described by Burgess (1925): the older area becomes the residence of the middle class while the upper class lives in the newer, larger homes. When the new lot

Figure 3.3: The Effect of Land Quantity on Income

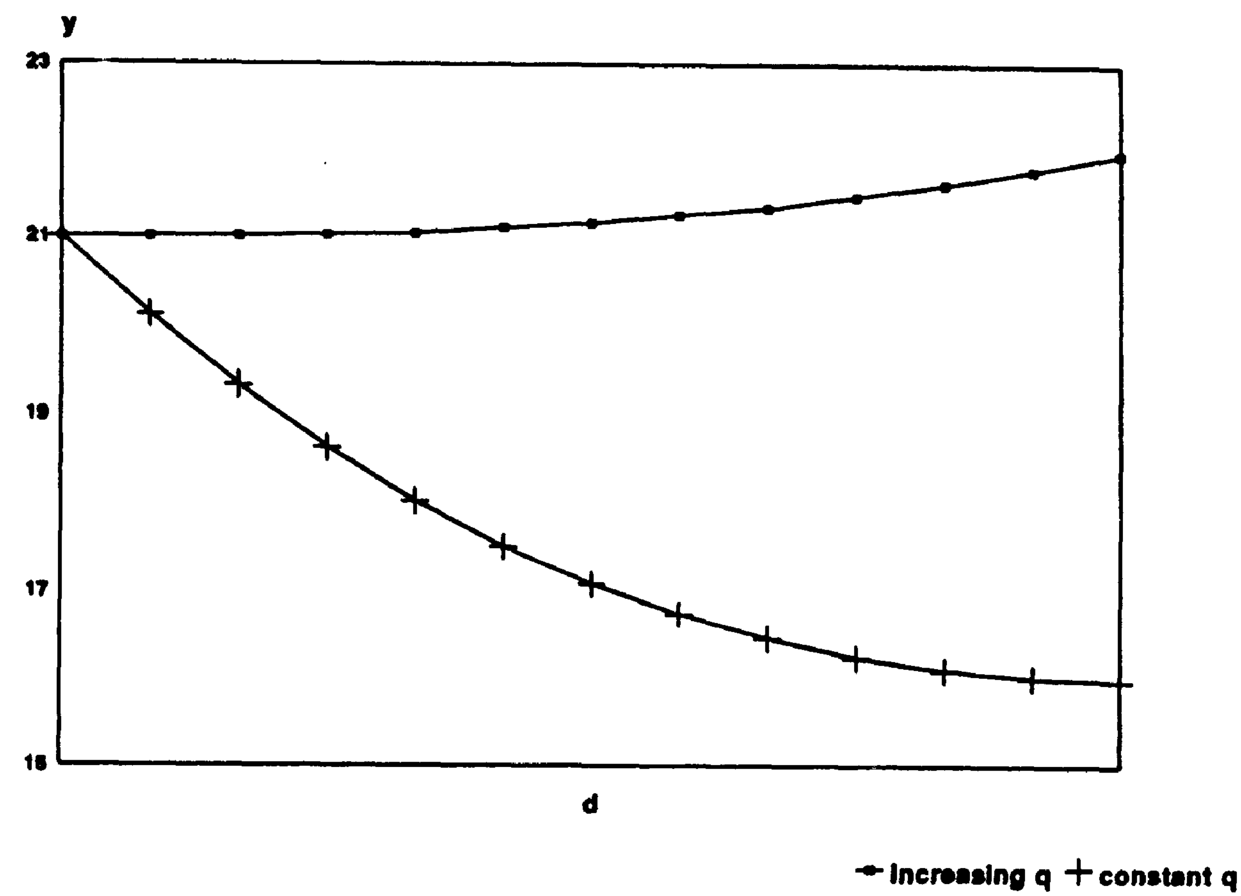


TABLE 3.1: THE EFFECT ON INCOME OF AN INCREASING QUANTITY OF LAND

p_g	g	h(d)	q	r(d)	y
1000	10	1000	10.0	1000	21000
1000	10	900	11.0	1100	21000
1000	10	810	12.1	1210	21011
1000	10	729	13.3	1331	21027
1000	10	656	14.6	1464	21042
1000	10	590	16.1	1611	21110
1000	10	531	17.7	1772	21171
1000	10	478	19.5	1949	21270
1000	10	430	21.4	2144	21346
1000	10	387	23.6	2358	21491
1000	10	349	25.9	2594	21633
1000	10	314	28.5	2853	21802
1000	10	282	31.4	3138	21993

TABLE 3.2: THE EFFECT ON INCOME OF A CONSTANT QUANTITY OF LAND

p_g	g	h(d)	q	r(d)	y
1000	10	1000	10.0	1000	21000
1000	10	900	10.0	1100	20100
1000	10	810	10.0	1210	19310
1000	10	729	10.0	1331	18621
1000	10	656	10.0	1464	18024
1000	10	590	10.0	1611	17511
1000	10	531	10.0	1772	17082
1000	10	478	10.0	1949	16729
1000	10	430	10.0	2144	16444
1000	10	387	10.0	2358	16228
1000	10	349	10.0	2594	16084
1000	10	314	10.0	2853	15993
1000	10	282	10.0	3138	15958

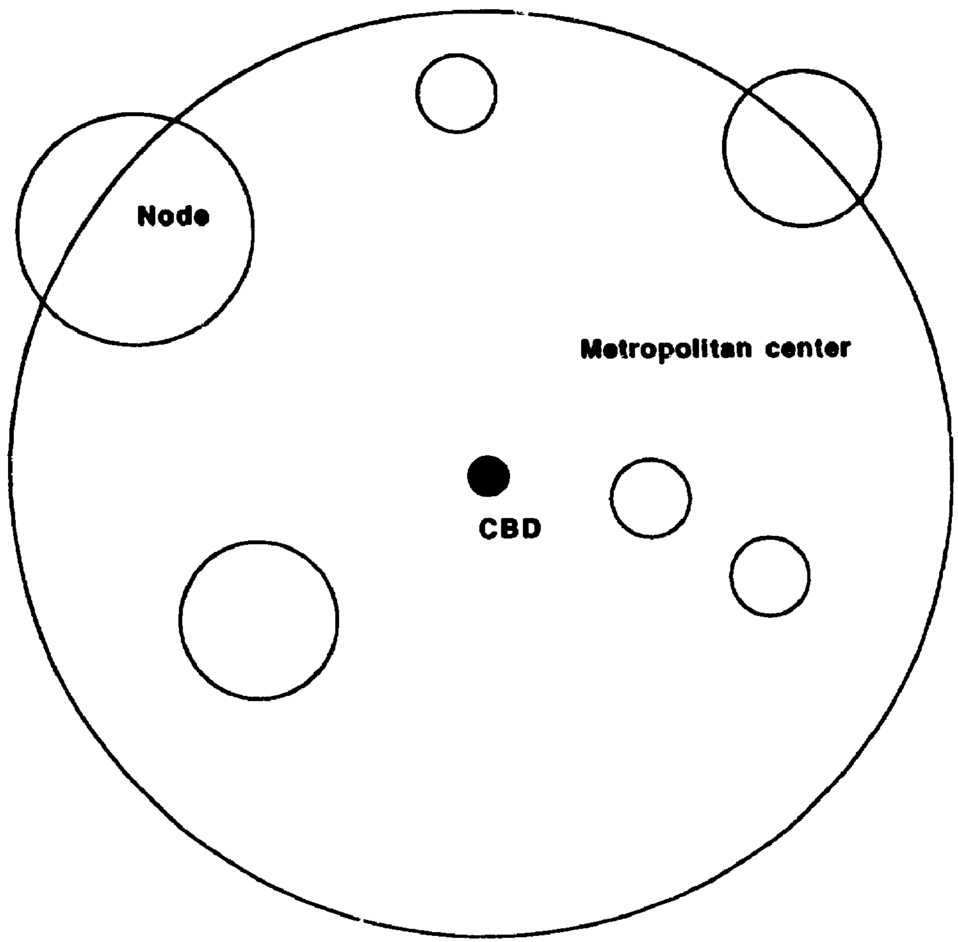
size available to the rich is restricted, they buy the older large homes on the large lots to obtain the space or continue to locate closer to the core as accessibility increases in importance. The lower socioeconomic groups are then left to purchase their best option: the newer smaller residences that are situated farther out from the core. This restriction has caused, in effect, a reversal of the rings and a centripetal shift of the location of higher socioeconomic households. Limiting lot size has forced a revaluation of new versus existing stock and has deteriorated the standard income location pattern.

The locational effect on household utility is complicated when the model assumes a polycentric form. The central business district (CBD) remains the primary location of jobs and other activities. People commute to this destination in significant volume throughout the metropolitan area (Gera, Betcherman and Paproski, 1978; Muth, 1985) and are not concentrated in the circumjacent residential areas. Distance from the center is still an influence on housing and commuting costs and thus affects household utility. This is consistent with the classical approach. The accompanying deconcentration and decentralization of employment opportunities, especially in manufacturing and non managerial office functions (Code, 1983; Goldberg and Mercer, 1986) has contributed to the rise of a polycentric metropolitan area. These suburban and exurban employment concentrations are often followed by various retail and service functions creating complementary locations that provide attractions similar to the CBD but at a smaller scale. The presence of a number of centers separated in space is combined with the dominant CBD to create a polycentric landscape (Figure 3.4).

When considering household satisfaction, the distance to each center, d_1, $d_2, \ldots,$ and so on, must be weighed instead of simply distance from the core, d. The attractivity of each center must also be included as larger centers will contain more potential opportunities than smaller ones. Different people will be attracted to different degrees toward each center depending on their household location (which affects relative distance) and that node's potential. This will be reflected in their utility levels. Distance must therefore be regarded as a function of the relative degree of accessibility to potential activities, a, afforded by the household's location, l.

Prior to the imposition of a lot size constraint on new development, the patterns within the residential areas surrounding the centers are similar: residential and population densities and housing costs decline with distance from each core. In areas where the residential occupancy of two or more centers overlap, the separating boundary is determined by the condition that identical households will attain the same utility level regardless of employment

Figure 3.4: The Polycentric Landscape



location[8].

The effect of considering a polycentric metropolitan area on the budget equation is the replacement of the measurement of distance from the CBD, d, with an index of the relative accessibility of a specific location, a(l). Thus, households maximize their utility through the interchange of the desirability of the residential site and the relative accessibility afforded by that location. This suggests household income and the volume of land and housing purchased do not consistently decline with distance from the center.

In the new model, housing value is affected by the nature of the structure, its site attributes and the relative location in the metropolitan area. The consideration of different centers existing in the same urban expanse and the resulting importance of relative accessibility instead of distance from the core have altered the traditional rent pattern (i.e. that the rent gradient consistently declined from the CBD).

The effect of smaller centers within a metropolitan center on the rent gradient is depicted in Figure 3.5. The population of the metropolis A encompasses those populations surrounding centers B and C. The residential prices near the two

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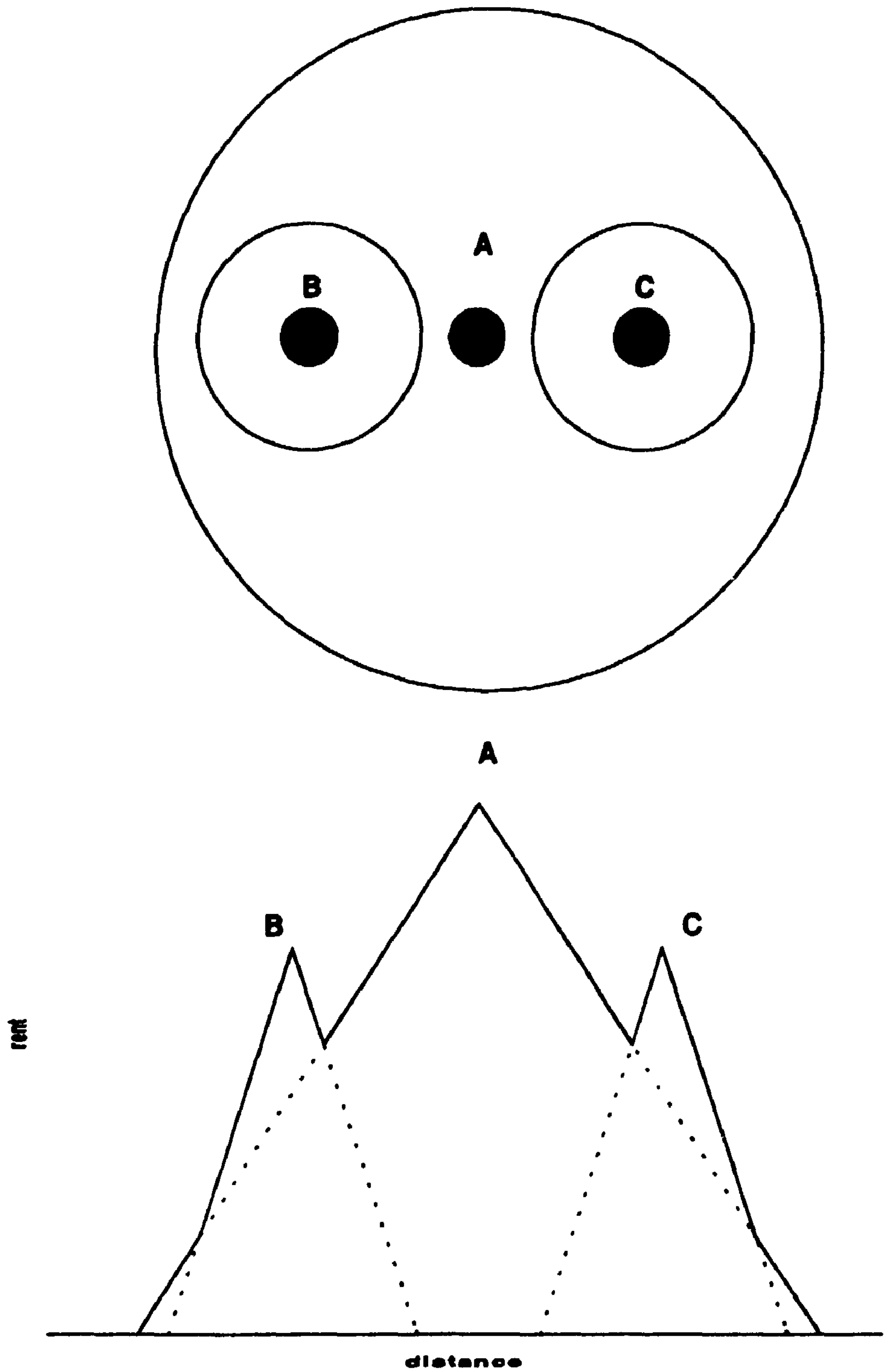
[8] This argument is supported in Alonso's (1964: 134) discussion of competing identical independent centers and Muth's (1985: 598) analysis of non CBD employment concentrations.

Figure 3.5: The Effect of Polycentricity on the Rent Gradient



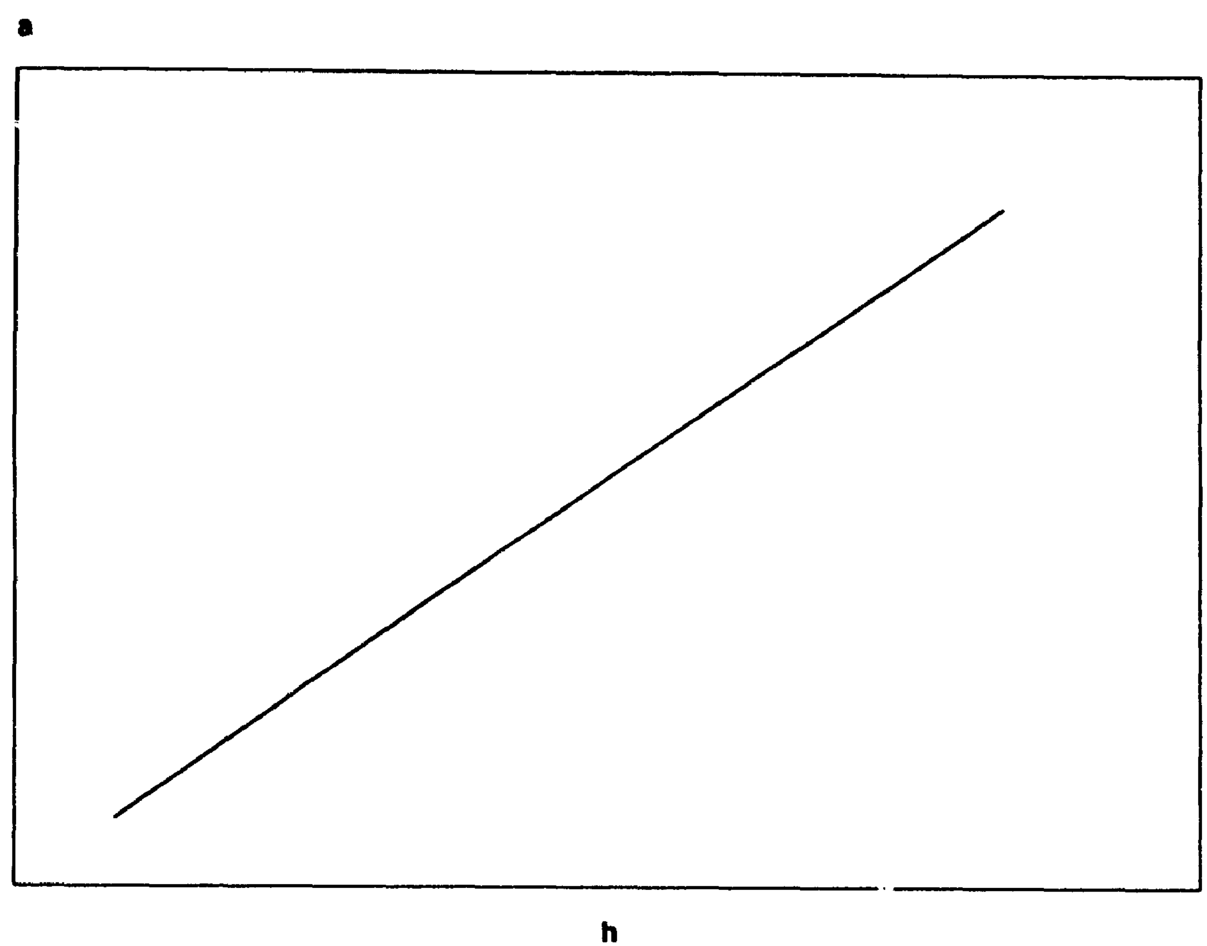
after Alonso (1964)

secondary nodes are higher than those required if only A existed, because of the increased relative accessibility achieved at B and C. The marginal prices are determined in competition between the residents geared to center A and those willing to pay higher prices to obtain the accessibility related to centers B and C.

When relative accessibility, a(l), is substituted for distance, d, in the budget equation the housing expenditure is represented by the function h(a(l))q, where h is the per unit housing and land price (subject to a(l)) and q is the quantity of housing and land consumed. It is evident that a household may not be able to purchase more land with increased distance from the CBD because of the changing degrees of relative accessibility resulting from the polycentric nature of the metropolitan center. Similarly, a household can improve their accessibility by moving closer to a center. In previous theory this was obtainable by moving toward the CBD only. The increase in location rent depends upon the relative accessibility of that new location, which is directly affected by the importance of the center in question. Thus, greater relative accessibility commands a higher per unit housing price (Figure 3.6).

Different locations contain different attributes, lot size being foremost, and these are reflected in the dwelling value at that site. Housing cost is determined by dwelling value

Figure 3.6: The Relationship Between a and h



and the fully capitalized advantages of its location. The effect of constraints on lot size and the unavailability of increased space in newer developments is of particular importance in terms of the spatial organization of income, as discussed previously. For a specific location a greater quantity of land and dwelling results in a higher total price. It can no longer be assumed that distance from the core is directly related to land availability.

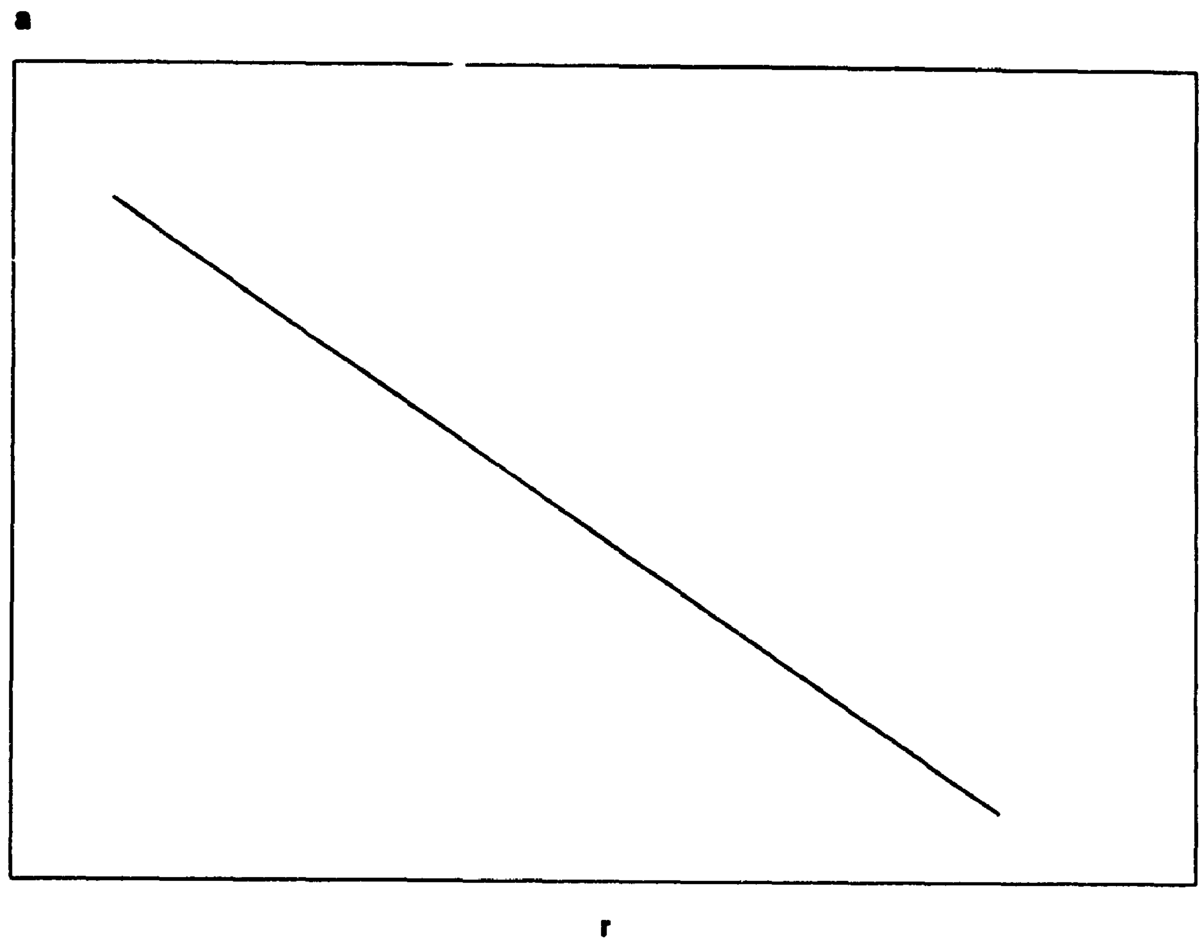
Alonso (1964) assumes the housing variable to include land only, all land is of equal quality and available quantity is not restricted. Muth (1969) includes housing quantity with land quantity; he also assumes housing quality declines with age. Gera and Kuhn (1977) further refine this variable by assuming housing is a function of structural type (a proxy for residential density), quality (represented by age of the dwelling) and housing quantity (indicated by number of bedrooms). In their case study of Toronto they include a dummy variable to indicate the nearness of workplace to Lake Ontario (presuming this would influence workplace rent levels due to its attractiveness attributes). All the above assume that there is no restriction on space in newer developments and that the housing situation desired by upper income households is not constrained by distance (i e. newer developments). The importance of considering the land quantity and the dwelling is obvious. With regard to the increased constraints on residential development and lot size and the construction of a wide range of dwelling sizes in each structural type, the validity of the use of type as a proxy for density is questioned. Basing quality on dwelling age only does not reflect the locational advantages inherent in each site. Considering the large proportion of the housing stock that was constructed within the last two decades (see Canada Mortgage and Housing Corporation, Canadian Housing Statistics, Ottawa: Canada Mortgage and Housing Corporation, 1970-1987) the importance of age as an indication of quality is limited. Similarly, the use of number of bedrooms to define quantity gives no indication of space or lot size, an important component of the total housing purchase.

Traditionally, the transportation expenditure has been dealt with in terms of the cost of commuting to the center of the city, r(d). Accessibility was a direct function of distance from the core. This corresponds to the assumption that all employment, goods and services are available only at the urban core. It is justified to assume that the greatest proportion of total trips is related to work and obtaining goods and services i.e. shopping and many leisure oriented activities, but it is not realistic to assume a single destination. In contrast to earlier works, such as the Alonso-Muth framework, the transportation expenditure component is dealt with in terms of the location's degree of accessibility to potential activities.

To incorporate the polycentric urban form, the transportation expenditure is considered to be a function of the relative degree of accessibility afforded by the household's location to potential activities. This is represented by the function r(a(l)) where r is the commuting costs incurred subject to the relative accessibility, a, of location l. In accordance with the arguments posited above, locating at a certain distance from the CBD does not result in a consistent transportation expenditure. Commuting costs can be reduced by increasing relative accessibility through location change. This does not necessarily require movement toward the core. Thus, a location of greater accessibility incurs lower commuting costs (Figure 3.7).

The final variable in the budget equation is the composite good expenditure. Households may purchase a wide variety of goods and services, g_1, g_2, ..., at different prices, p_1, p_2, ..., and in various quantities. For simplification and in accordance with the framework discussed above all goods and services available are combined into one composite good, g, and their costs into one price index, p_g. Generally, prices and availability of goods and services are consistent throughout an urban area. If an item or service is restricted in location the additional expense in obtaining it will be reflected in the transportation expenditure assumed in the selection of housing location.

Figure 3.7: The Relationship Between a and r



The household budget equation can now be expressed as follows:

$$y = p_g g + h(a(l))q + r(a(l)) \qquad (3)$$

where
y : household income
p_g : price index of the composite good
g : quantity of the composite good
$a(l)$: relative accessibility at l
h : per unit housing and land price incurred at l
q : quantity of land and housing
r : commuting costs incurred at l
l : location within the metropolitan area

The model allows households to simultaneously choose their residential location and the quantity of housing, through utility maximizing behaviour subject to budget and development constraints. It tests the proposition that this behaviour can explain the resulting intraurban income distribution pattern.

It is assumed that employment centers exist throughout the metropolitan area i.e. the city is polycentric, and that each significant employment center is surrounded by residential use; rent gradients decline away from these nodes. The relative location of a residence with regard to its proximity to different employment centers influences its rent level or value i.e. land value is a function of accessibility. This is consistent with the assumptions of Beesley and Dalvi (1974) and Gera and Kuhn (1977). Declining land value gradients has been empirically established by Yeates (1965), Berry and Horton (1970) and Mills (1972). Empirical tests conducted by Thrall and Feather (1987) support the relationships between land value and population, and land value and population density.

Similarly, the distribution of jobs, services, shopping facilities, and cultural and recreational opportunities (indicated by the respective employment levels at various locations) also affects this value. The total of all categories of employment per location is an overall subrogate for all potential journeys. It is posited that the amount of retail employment at a location is indicative of the amount of shopping facilities available there. Analogous to this, the importance or availability of services is reflected in its distribution of jobs. The same argument can be applied to cultural and recreational opportunities, and the potential for employment of household members. Therefore, the amount of employment at a center is related to the amount of activities (i.e. jobs, shopping facilities, services, etc.) that are available to the household at that location. The larger the employment (and thus activities) the greater the potential to travel there.

The accessibility of a location is a function of the employment potential at that location and at all other locations within the metropolitan realm, with regard to the distances between that location and all others. The potential of a site varies directly with the surrounding employment opportunities and inversely with the relative distances[9].

The employment potential values are measures of relative accessibility to employment, goods, services, etc., and are based on the formula:

$$EP_i = \sum_{\substack{j=1 \\ j=i}}^{n} E_j * e^{-d_{ij}\beta} \qquad (4)$$

where EP_i : employment potential at location i
E_j : employment at location j
d_{ij}: distance between location i and location j
n : total number of locations
β : distance decay parameter
e : base of the natural logarithm

The potential value is a measure of the relative accessibility of a location to potential activities. Accessibility can be calculated as:

$$a_i = EP_i \qquad (5)$$

It is assumed that housing value is affected by the nature of the structure, the dwelling size, the lot size, and relative location within the metropolitan area. It is influenced by

[9] This approach is similar to that used by E. Brigham (1971) in his analysis of the determinants of residential land values.

nearby dwellings, the open or available space encompassing the site and the immediate land area[10]. These structural and locational characteristics are reflected in (i) the average floor area and (ii) the average site area measurements and in (iii) a composite measure involving both components.

It is argued here that the greatest effect of constraining lot sizes is seen in single detached developments. Forms of multifamily housing (in particular apartments and row housing) are built at higher densities regardless of lot restrictions and are less affected by these land constraints. Therefore, the greatest change in space and the most altered aspects of the housing market are occurring in the lowest density component - the single detached dwelling.

The quantity of housing available at a location is a function of the lot size and dwelling size at that location. Dwelling and lot size values, given in terms of floor area and site area units, represent the major elements of the composite space consumed. A composite measure can be calculated by combining the relative values of these two measures. These can be expressed in terms of the number of dwellings per areal quantity:

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[10] Thrall (1979) examines the provision of different types of public goods (such as parks) where usage and bid rents are related to residential site proximity.

$$q_i = F_i \quad (6)$$

$$\text{or} \quad S_i \quad (7)$$

$$\text{or} \quad C_i \quad (8)$$

where q_i: floor area, site area or composite area at location i
F_i: floor area at location i
S_i: site area at location i
C_i: composite area at location i

Lot size is the component most affected, obviously, by land constraints. Larger single detached homes are still constructed, but are situated in a much reduced space. It is this dwelling type that is most affected by the changes in lot sizes. Other forms of housing (i.e. multifamily dwellings) continue to be built at higher densities on smaller land areas per household and are not modified to the same degree. The increasing unavailability of large plots at the periphery has limited their locations to established areas well within the metropolitan realm. This restriction has caused a revaluation of the market worth of a larger lot.

This relative increase in value is made more dramatic when the average lot cost proportion of the total cost of new single detached housing is examined. The major urban areas of Ontario experienced an increase in this proportion from approximately 20 percent in 1966 to almost 34 percent in 1976; in Toronto the percentage rose from 30 to 49 (Greenspan, 1978). Considering that single detached dwellings account for over one half of the total housing stock (Canada Mortgage and Housing Corporation, 1984b), the overall effect on housing prices is substantial.

The household budget equation applicable to location i can be rewritten as:

$$y_i = p_g g + h_i(EP_i) * (q_i) + r_i(EP_i) \qquad (9)$$

This represents the maximization of the household's utility with full consideration of development and income constraints. The most appropriate means to estimate the variables is discussed in the section entitled "Method".

CHAPTER 4:

THE SETTING OF THE CASE STUDY - A RECENT HISTORY OF PLANNING AND DEVELOPMENT IN METROPOLITAN TORONTO

4.1 Introduction

Empirical verification of the model is based on Metropolitan Toronto. Government planning continues to play an important role in the nature of its development (Spelt, 1973). Emerging space restrictions and continued pressure for containment of growth are contributing to variations from the norm in Toronto's density profile. The combination of its expensive land and housing market and the presence of planning and development controls are creating a scenario that contrasts those of the classic economic and sociological models. A brief overview of the recent history of planning and development in the Toronto realm is presented below.

4.2 Pre-war Development and Planning

During the pre World War II period, most growth in Toronto occurred toward the north and west (a trend that is still continuing)[1]. This included the establishment of a number of satellite communities, located just outside the city

[1] Four major contributors to this directional bias have been identified: (i) the difficulties in bridging the Don River to the east, (ii) the importance and orientation of Yonge and Dundas streets for hinterland access (northward and westward, respectively), (iii) the siting of the Grand Trunk Railway main line to the northwest in the mid 1800s, and (iv) the influence of the urban centers being established in the Southwestern Ontario agricultural hinterland (Kerr and Spelt, 1965).

boundaries. By the time these suburban villages were merged with the city[2], they often had well developed shopping facilities and trade areas. Thus, the establishment of commercial nodes in locales other than in the city center began at an early stage (Spelt, 1973).

The introduction and later expansion of streetcar routes (such as the Yonge Street line) augmented urban residential growth. These routes did not significantly extend beyond city boundaries, due mostly to previous annexations (Spelt, 1973). This helped keep the density of the developments high, by North American standards. Relph (1987, 1990) points out that in the 1930s Toronto's population density was most likely exceeded (in North America) only by New York City[3]. Working class residential areas continued to expand, often adjacent to streetcar routes. New suburban upper income areas developed to the north and to the west, typically containing large, single detached homes constructed at low densities (Whiteson, 1982). By the end of this time period the city had taken on a distinctive star shape (Figure 4.1).

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[2] Generally, the city expanded by consuming these newly built up towns. The annexation of Yorkville in 1883 started a series of expansions which ended in 1912 when North Toronto was annexed. This large increase in undeveloped land resulted in little annexation activity in the following decades (Government of Ontario, 1965).

[3] This maintenance of high density was an important factor in the construction of the initial segments of the subway system in the 1950s.

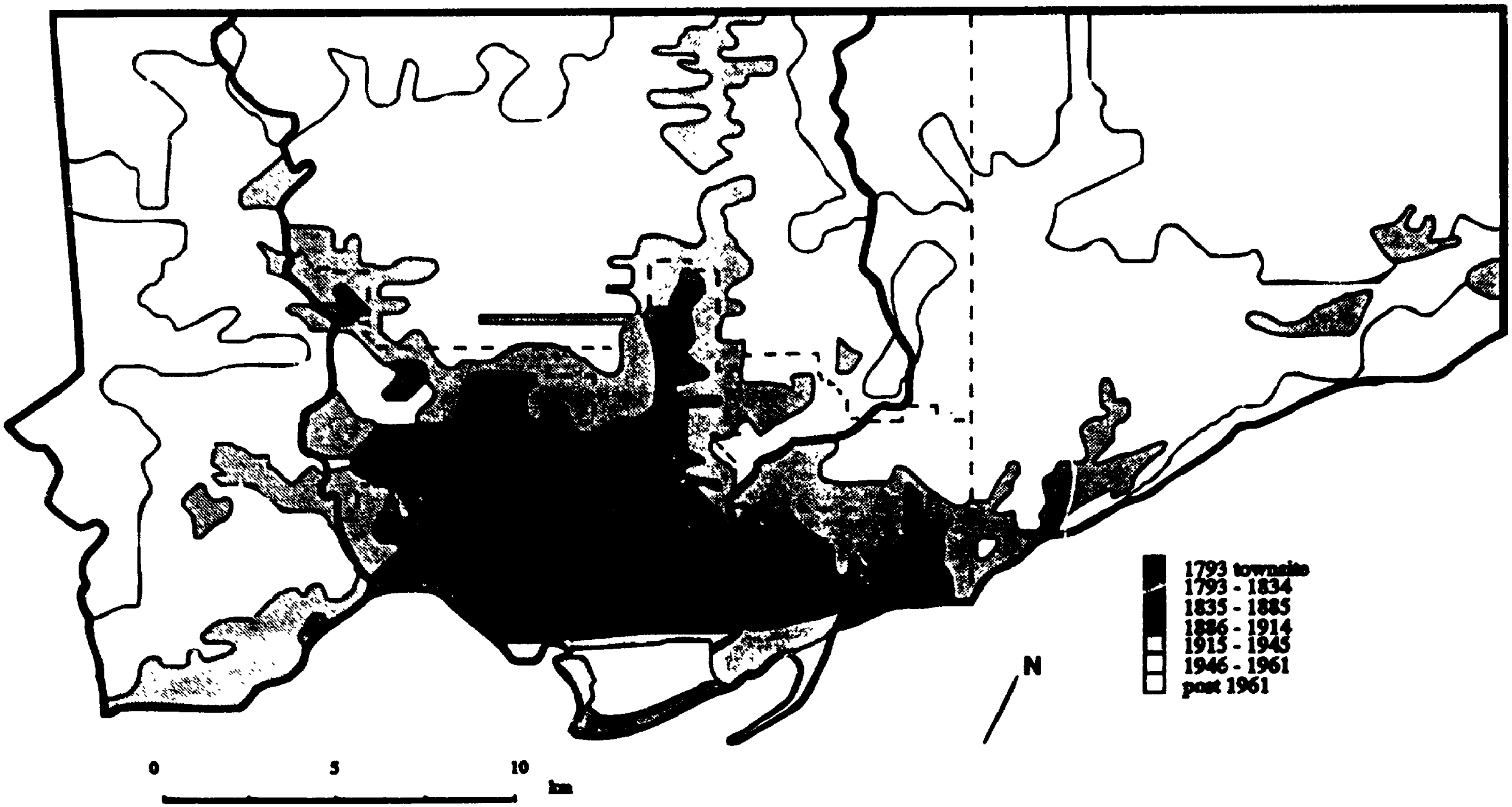

Figure 4.1: The Historical Growth of Metropolitan Toronto

Source: Murdie, 1969

From a planning perspective, this was an era of minimal governmental influence. The typical approach to planning was to only take decisive action after the situation became extreme. Municipal government functioned on the precept that the best governed are those that are the least governed (Spelt, 1973). The disbursement of public funds was viewed as an expenditure and rarely as an investment. This reflected the utilitarian and business principles that dominated white, anglo saxon protestant Toronto at this time.

Early attempts at civic improvement in this century were oriented toward city beautification - the Civic Guild[4] was the formative authority in this regard (City of Toronto Planning Board, 1959). Despite their efforts, most of the development of planning done up to World War II lay in the sights of the surveyor's office, and was almost entirely concerned with street and traffic problems. This reflected the attitude toward minimal planning interference[5]. Still, the Guild was instrumental in the establishment of the City and Suburbs Plans Act in 1912. The Act gave the City elements of control over land subdivision, servicing and road construction for developments up to eight kilometres beyond

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[4] The Civic Guild, originally known as the Toronto Guild of Civic Art, was formed in 1897. While it was a non-governmental body, the membership included many prominent citizens. Thus, it was an influential lobby group.

[5] There was an administrative move in the 1930s, however, as this office was expanded and renamed the Department of City Planning and Surveying.

the City limits. This was the first planning legislation in Ontario (Relph, 1990). Thus, the perceived civic need to control growth on a large scale was first legislatively satisfied in the early twentieth century. This was precursory of government attitudes and perceptions to come in the post war period.

From 1930 to 1945 the depression and the World War forced the reduction of municipal expenditures on services; the need did not diminish, it merely was not satisfied. Population growth continued, but at a relatively slow rate. Much of this growth took place outside of the City of Toronto, in suburban municipalities and townships (Government of Ontario, 1965). By the onset of World War II, the star shaped morphology of Toronto had remained basically the same with one exception: an eastern prong along the lakeshore developed (following the Kingston Road and the rail lines). Little infilling between the four prongs took place (see Figure 4.1).

Thus, the notion of growth along a concentric periphery, while popular in the classical urban form and land rent-related literature, is not appropriate for the historic growth of Toronto. Its pattern of expansion prior to World War II corresponded to a streetcar-induced, star shape. Further, residential densities did not consistently decline with distance, as borne out by the locations of working class areas. Lastly, the emerging importance of the multiple nodes of commercial activity contradicts the assumption of monocentricity, also prevalent in the related literature. One point with regard to planning deserves repeating: the City and Suburbs Plans Act (1912), while initially limited in its scope, illustrates the early perceived need to influence or control development both within and beyond its borders.

4.3 Post War Toronto

Planning rose to the forefront during the Second World War, when the Toronto municipal government was contemplating postwar reconstruction and expansion. Following on the recommendation from the Board of Trade, the Toronto City Planning Board (an advisory body) was created in 1942. It presented a comprehensive master plan for the city and the surrounding areas in 1943. The plan was approved by City Council, stating:

> ...it being understood that the said approval shall not be construed as committing the city to proceed with the plan or any particular part thereof without the approval of council, which is hereby expressly reserved. (Kerr and Spelt, 1965:102)

Thus, the political conservatism that plagued the development of planning from 1900 continued to exist. The political fear of assuming responsibility in planning kept elected representatives tentative at best. Still, the work of the advisory board impacted on the developments that took place in the 1940s and 1950s. The board also contributed to the advancement of planning, at both municipal and provincial levels.

Within the comprehensive nature of the 1943 plan, it was evident that certain aspects required coordination between the metropolitan area municipalities, and possibly some form of metropolitan government (Government of Ontario, 1965). Suburban development outside of the city created severe municipal problems such as inadequate water supply and sewerage, and a poorly integrated transportation system. Toward this end, the necessary provincial legislation was obtained in 1947 and the City of Toronto's first official plan was approved in 1949.

Fundamental to the principle of the planning framework was the extension of the planning area beyond local boundaries. This had been adhered to since the City and Suburbs Plans Act of 1912. To coordinate the activities of the different municipalities to meet their growth demands, the Municipality of Metropolitan Toronto was formed in 1953. It was composed of the City of Toronto, and the boroughs of East York, York, Etobicoke, North York, and Scarborough (and their communities)[6].

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[6] In 1953 the "original" Metropolitan Toronto contained thirteen political units (see Figure 4.2). In 1968 the Provincial government reorganized the metropolitan system, reducing the structure to City of Toronto and five surrounding boroughs. In 1984, Metropolitan Toronto became a federation of five cities (Toronto, York, Etobicoke, North

Its primary purpose was to increase local government efficiency by standardizing service and transportation networks. Specifically, the metropolitan government was responsible for water supply, sewerage, education, major roads, public transit, and assessment (Government of Ontario, 1965). The local planning boards kept their autonomy with regard to formulating and amending their own plans (provided they conformed to the metropolitan plan), and in terms of responsibility for certain local services. Further, a larger Metropolitan Toronto planning area was delimited (see Figure 4.2)[7]. Thus, once again governmental influence through planning extended beyond the political boundaries.

The rapid growth of the outer suburbs following the creation of Metropolitan Toronto is shown in Figure 4.1. The major trend during this period was the infilling of the interstitial spaces of the traditional star shape. This is especially true of the area between the eastern and northern prongs (i.e. Scarborough). This wedge of open land, extending almost to the core, was not developed until the early 1950s.

York and Scarborough) and one borough (East York).

[7] In 1959 the first official plan was issued - but not approved. In 1966 the Metropolitan Toronto council accepted a revised version of the 1959 plan. It too was not given the status of an official plan, but instead was considered a "statement of policy" and thus "a guideline for future development" (Spelt, 1973).

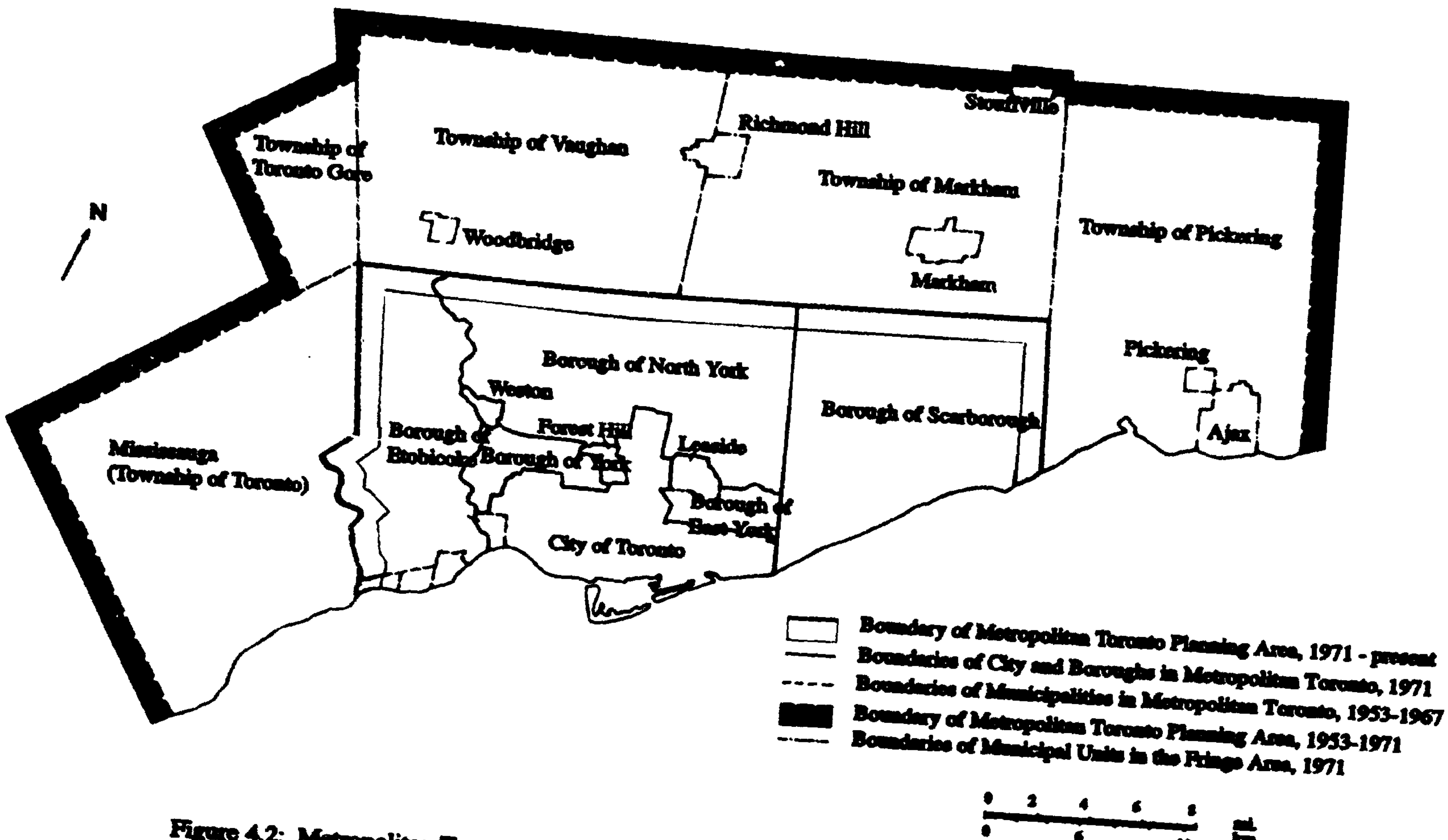

Figure 4.2: Metropolitan Toronto Administrative Units

Source: Spelt, 1973

Beginning in 1952 and continuing until 1962 the corporate development of the community of Don Mills transpired in the center of the Scarborough wedge. This 800 plus hectare land assembly was comprised of single detached houses, low rise apartments, and retail and office space. The development was extraordinary for its wide range of housing. The planning encouragement of housing mix by type and tenure in new development is still prevalent.

This is not to suggest that the bulk of the growth took place in Scarborough. The post war development in greater Toronto was similar to most metropolitan areas in North America, in that it was characterized by rapid growth throughout the suburbs. For example, the rural township of North York in 1945 contained a population of 26,000; by 1964 it was the fifth largest municipality in Canada with more than 340,000 people (Government of Ontario, 1965).

The 1959 "unofficial" plan proposed complete development of the wedge of land in Scarborough. The building of the Don Valley Parkway greatly assisted in this progression by offering a direct north-south route into the core (Spelt, 1973). Similarly, the construction of Highway 401, the Gardiner Expressway, and the Yonge Street subway line all contributed to the development of the suburban boroughs within Metropolitan Toronto through the improvement of their relative accessibility.

The plan of the Metropolitan Toronto Planning Area encouraged the continued infilling of the interstitial spaces of the traditional star, to the point of rejecting the possibility of establishing satellite towns. A broad, urban ribbon running along the lakeshore was desired, with the exception of a northern extension along Yonge Street. This has resulted in a continuously built up urban area of relatively higher densities (than other comparable North American cities).

Residential suburban growth since the 1950s has increasingly been the result of large corporate developments[8]. These large corporations preferred large tract projects. Concurrent with this, the metropolitan plan and the nature of the related approval processes favoured such expansions (Spurr, 1976; Gallion and Eisner, 1975). Facets of the process and related problems are described by Spurr (1976:114-115):

> Governments are vitally involved in... site preparation, as this usually includes the creation and approval of a detailed plan of subdivision with all related services, and often requires a zoning bylaw and the amendment of an official plan. The subdivision approval process is not standardized, criteria for approval also vary, and the process may involve upwards of 70 separate stages and over 30 different agencies. The average plan approval period, assuming trunk

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[8] For example, the firms of Cadillac, Greenwin and Meridian, formed in the 1950s, were followed by corporate developers such as Tridel, Campeau, Wimpey, Runnymede and Olympia-York. For information concerning land holdings and development corporations during this era, see Spurr (1976).

> services are available, is one to two years, while official plan amendments add an average of 4 to 6 months, and a contested zoning change (most are) requires at least four months. These characteristics constitute severe problems in that: small firms have difficulty raising and carrying capital for the extended period required to move land through to approval; innovative design is discouraged as "status quo" projects may clear the process more quickly; and the uncertainty associated with this complicated system precludes even the largest developers from maintaining the team of specialized labour and equipment necessary for sustained, efficient, high volume production.

The result was often speculative built, large residential subdivisions containing planned mixes of housing types (purposely segregated within the residential tract). Single detached dwelling developments usually contained three or four architectural styles, continually repeated. These large scale, repetitious expansions are often referred to as "cookie-cutter subdivisions" or "legoland" because of their lack of variety and monotonous tone.

The concern in the 1960s with planning for regional transportation systems (especially expressways, etc.) and service provision led to major regional planning studies instituted by the Province. In May 1970, the Ontario government presented its Toronto Centred Region plan, as a directive for the growth of Metropolitan Toronto and surrounding regions (Government of Ontario, 1970). The plan addressed the future location of residential, commercial, recreational, service and transportation functions. In 1969 the government began instituting its regional government programs.

Of specific interest were (i) the creation of the two-tier regional governments of Durham, York and Peel (and later Halton) surrounding Metropolitan Toronto (east to west respectively), and (ii) the reduction of the Metropolitan Toronto Planning Area to correspond with Metro's political boundaries (see Figure 4.3). This plan contained essentially land use policy plans for the Toronto Centred Region, and was not formally binding on the component regions (Hodge, 1991). Little came of the plan, and the Provincial government notion of establishing regional governments across Ontario was later abandoned.

However, it was recognized that the control of the spreading urban growth could only be achieved through integrated efforts by Metropolitan Toronto and the surrounding regional governments. This was increasingly important following the downsizing of the Toronto's planning area to the metropolitan unit. While it did reduce this spatial extent, the purpose of the Toronto Centred Region plan was to create a large planning area. As such it was an extension of the ideas of 1912, regardless of its eventual demise.

While neither the Metropolitan Toronto Planning Board plan nor the Toronto Centred Region plan had any binding

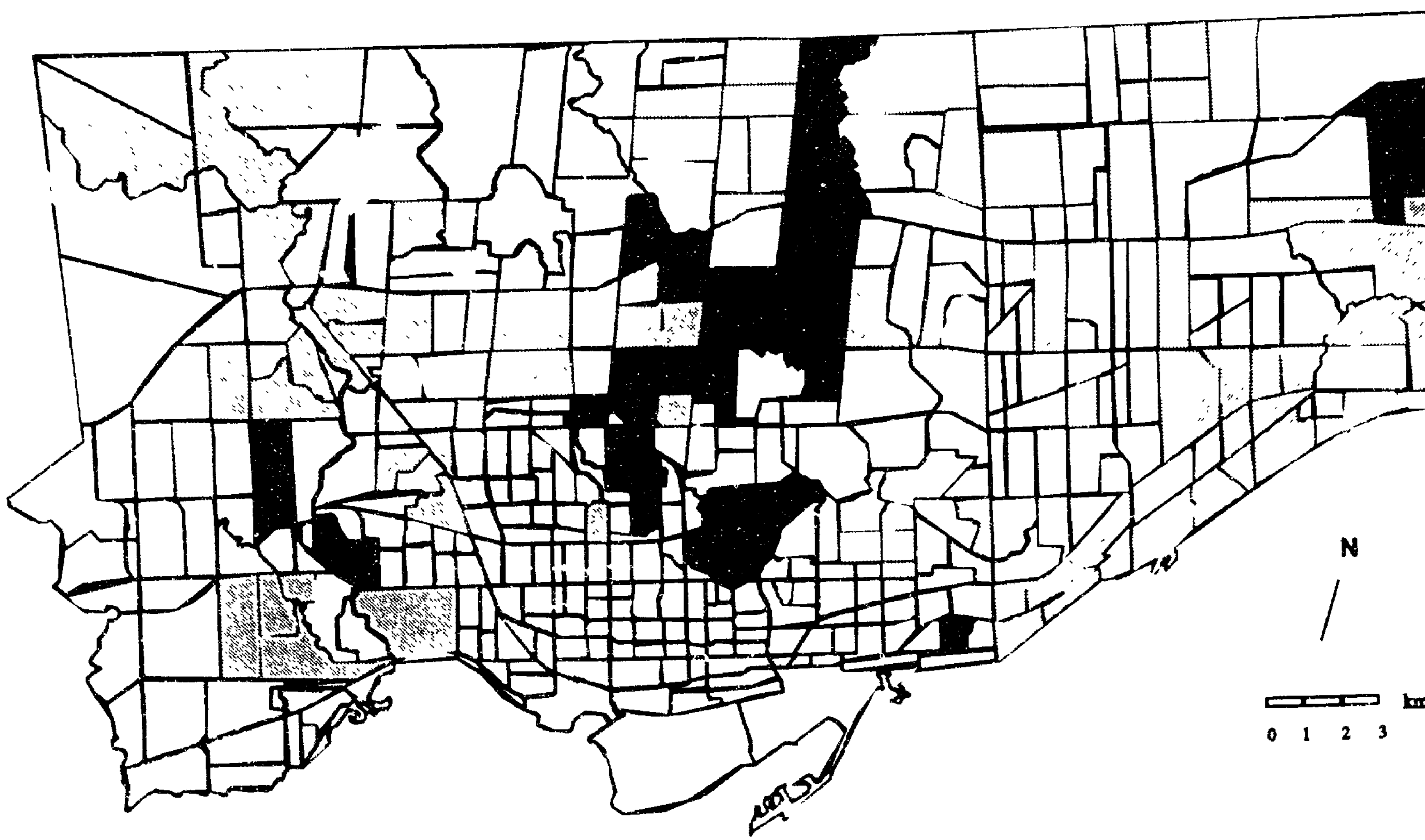

Figure 7.4: 1986 Dwelling Value

> +2 s.d. | > +1 s.d. to +2 s.d. | > average to +1 s.d. | average to -1 s.d. | < -1 s.d.

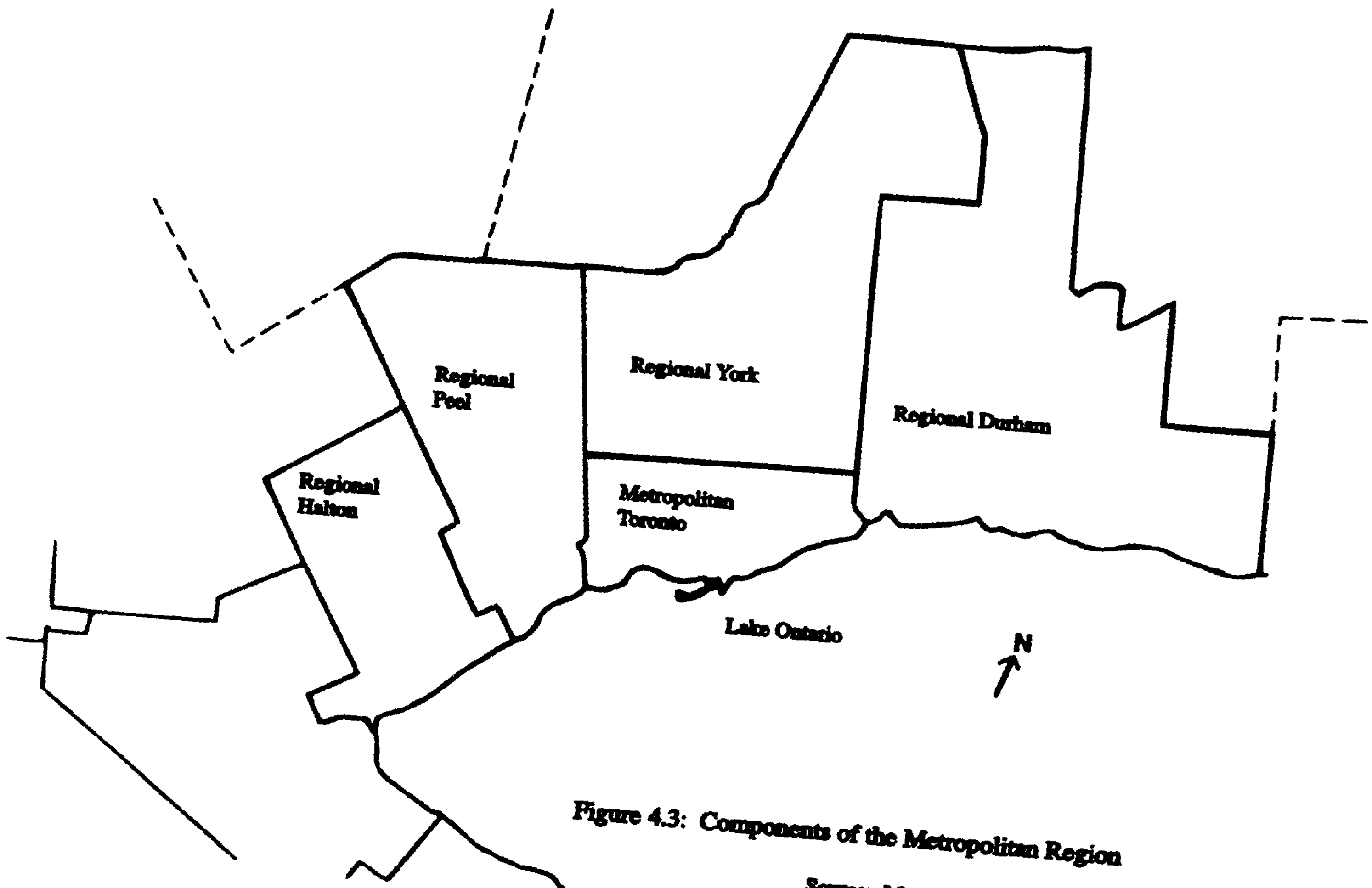

Figure 4.3: Components of the Metropolitan Region

Source: Metropolitan Toronto Planning Department, 1988 limitation on development outside of Metropolitan Toronto, there was a large volume of official documents and a substantive public policy that indicated the public sector intention to halt any sprawling expansion of Toronto (Spurr, 1976). Restricting the designation of appropriate land for development, when combined with the delays involved in site preparation (discussed above), added to the problems of short term supply. This scenario was amplified when one considers that while the land outside the metropolitan boundaries was being constrained from development, growth within Metropolitan Toronto was "to the point where, in 1978, the 244 square mile planning area is almost fully built up" (Metropolitan Toronto Planning Department, 1978:15).

Thus, the metropolitan unit was well established and functioning prior to the study period analyzed in this dissertation. The planning of development since the 1950s took place with an imposed metropolitan perspective - this provided a "spatial" consistency with regard to government requirements. Further, the bulk of new construction was located within Metropolitan Toronto, and increasingly took the form of large scale subdivisions. These usually contained a mix of housing types. The single detached dwelling stock of this period, when combined with those built under the Veterans Land Act, were constructed at low densities and on large lots, by present standards. The resultant landscape was heterogeneous with regard to dwelling types, densities, household income characteristics, etc. These do not exhibit the simple relationships between distance from the core and residential characteristics inferred in the bulk of the urban literature discussed.

Planning took on an increasingly influential role. On the one hand, subdivision approval processes became more involved and affected development within Metropolitan Toronto to a greater extent than previously experienced. On the other hand, attempts at regional government-based planning resulted in multiple tiers of government, all involved in restricting any sprawl outside of Toronto.

The end result was the infilling of Toronto by the late 1970s, establishing a more concentric periphery, and the creation of identical residential developments insofar as planning requirements (density restrictions, servicing, etc.) and internal structural characteristics are concerned.

4.4 The Past Twenty Years

The speculative boom of the early to mid 1970s has been well documented[9]. There is general agreement that the boom was created by a large increase in demand. This demand was the cumulative result of demographic factors, increasing income,

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[9] See for example, Bourne (1977), Bourne and Hitchcock (1978), Brown (1977), Goldberg (1976), Markesun and Scheffman (1977) and Smith (1977a).

inflation, and institutional changes in mortgage availability and tax policies. The problem was exacerbated by the limited availability of appropriate vacant land and the prolonged approval process resulting in a slow response to increasing supply.

Land and dwelling prices rose dramatically. From 1972 to 1975 nominal lot prices in the Toronto census metropolitan area skyrocketed by almost 105 percent: a rate in excess of fifty percent more than general consumer prices (Greenspan, 1978). In comparison, house prices rose by over seventy percent. Thus, housing in general and building lots in particular became increasingly expensive, relative to other goods and services.

Today, land and housing costs are among the highest in North America. Land prices are important since they influence development densities, servicing costs and housing prices (Toronto Area Liaison Committee, 1984). One major contributor to this has been "the severity of controls on the rural-to-urban land conversion process and the bureaucratic inefficiencies engendered by the system of controls" (Derkowski, 1972: 11). An assessment of the planning impact in Ontario by the Ontario Economic Council (1973: 87) notes:

> Unreasonable land prices for uses of any kind in all of the active development areas of the province are perhaps the most significant economic consequence of 25 years of municipal planning experience. ...the major reasons for high land

costs in most of Ontario's developing areas can be linked to the very successful containment of urban sprawl.

The high cost of housing (and land in particular) led to growing difficulties in affordability. For example, the average resale price of a home (including condominiums) within the Toronto Real Estate Board market area (Table 4.1) rose from $61,389 in 1976 to $266,000 in 1990[10]. This market area encompasses the bulk of the extended Toronto housing market, in terms of volume of activity. It includes Metropolitan Toronto, Mississauga, and the innermost parts of the regional municipalities of York and Durham that are adjacent to Metropolitan Toronto. This reflects the most significant areas containing the population of the region (see Figure 4.6).

TABLE 4.1: AVERAGE RESALE PRICE FOR THE TORONTO REAL ESTATE BOARD MARKET AREA ($000s)

1976	1978	1980	1982	1984	1986	1988	1990
61.4	69.0	75.7	95.5	102.3	138.9	240.0	266.0

(Source: Toronto Real Estate Board, 1976-1990.)

Because of the substantial price increases, housing became less affordable. This was especially true for ground related dwellings. "Affordable housing" is a term which refers to

[10] The average house price in Metropolitan Toronto in 1990 of $266,000 was actually a decline from 1989 prices, reflective of the present economic climate. Further, the average price for the Greater Toronto Area was only slightly less (Metropolitan Toronto Planning Department, 1990).

shelter which the bottom 60 percent of households (by income) could afford. According to the Ministry of Housing, the 1990 upper limit of affordability (i.e. the maximum price) was $158,000 (Metropolitan Toronto Planning Department, 1990). Thus, appropriately priced choices for the middle and lower income range households were rapidly disappearing. Even with fluctuating mortgage rates dropping to reasonably low levels at different times, and the increased wages and greater number of two income households, affordability was (continues to be) a very important issue in Toronto.

As the average housing price rose, so did the size of the required downpayment, making home ownership especially difficult for potential first time buyers. This scenario worsened due to the low rate of rental housing construction, which contributed to greater pressure on the rental market (Metropolitan Toronto Planning Department, 1989). When combined with chronically low vacancy rates and limited initiatives for the construction of social housing, these trends reduced the amount of the available housing for middle to lower income households (Metropolitan Toronto Planning Department, 1987a).

Figure 4.4 illustrates the distribution of estimated dwelling market values within the Toronto CMA for 1981. There was a distinct, sectoral distribution of values within Metropolitan Toronto at that time, and a spatial domination by average

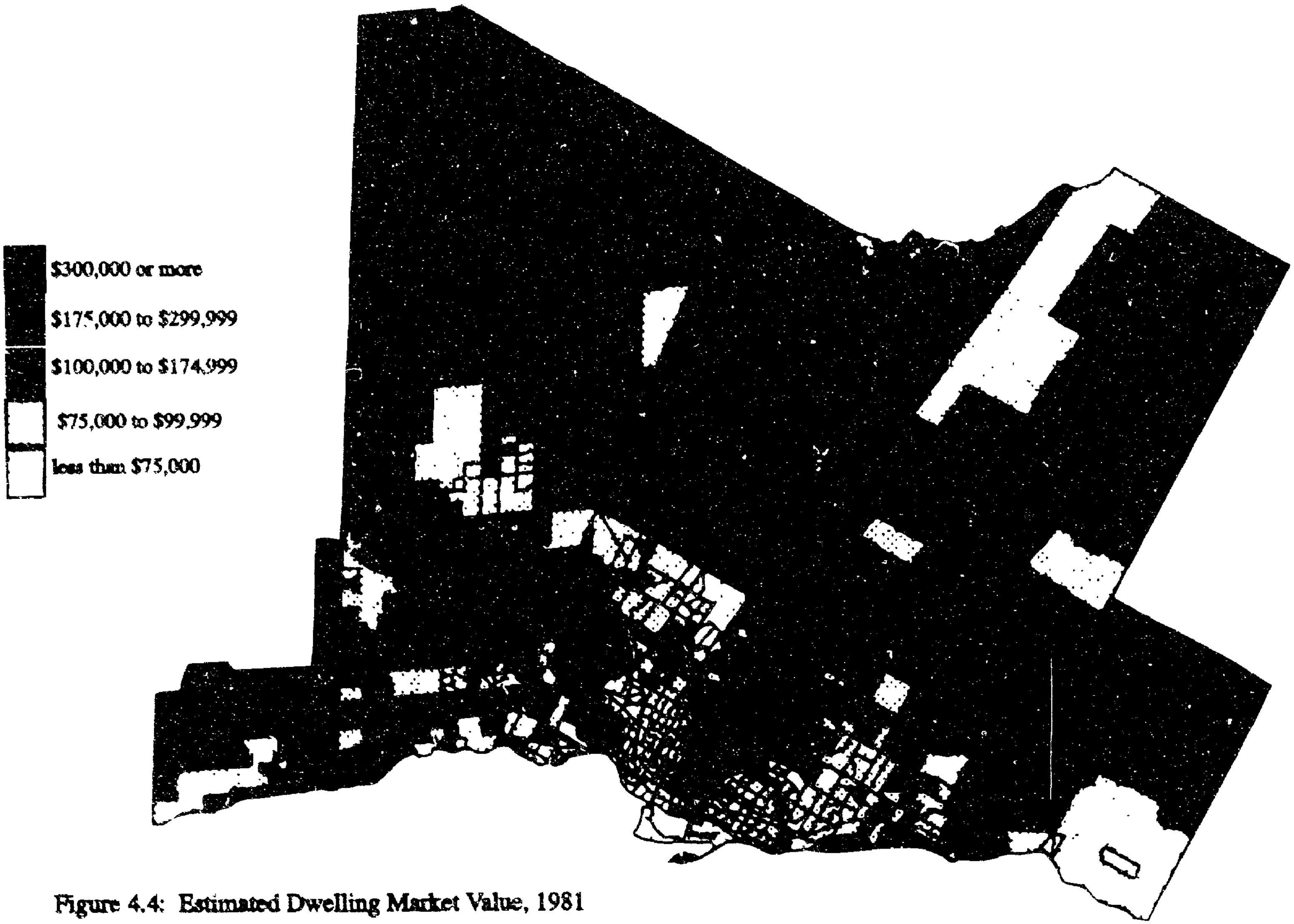

Figure 4.4: Estimated Dwelling Market Value, 1981

Source: Statistics Canada, 1981

value homes throughout the census metropolitan area[11]. The high value concentrations in the two census tracts north of Metropolitan Toronto are the areas of Caledon (to the west) and Markham (to the east). These predominantly rural areas contained older, extremely large estates. The lack of significant quantities of urban development and the large census tracts create a visual impression of greater importance than is perhaps appropriate. This raises two points which contrast the classical literature on urban form and land rent: first, the lack of any indication of a concentric pattern, and second, the lack of a pattern of dwelling value consistently increasing with distance from the core.

The spatial configuration of total private household income (1980) is shown in Figure 4.5. The initial impression is there is considerable difference between the income pattern and the map of dwelling value. When consideration is given to the actual number of households in the outer census tracts (i.e. considerably fewer than in or near the metropolitan center - see Figure 4.7) and the potentially misleading impact of their geographic size, the resemblance improves

[11] The average estimated market value for owned dwellings in 1981 was $114,000. The average resale price within the Toronto Real Estate Board market area was $90,200. The discrepancy is likely due to the concentration of below average value dwellings within the market area, and the significant difference in transaction volume (potentially reflected in population distribution map).

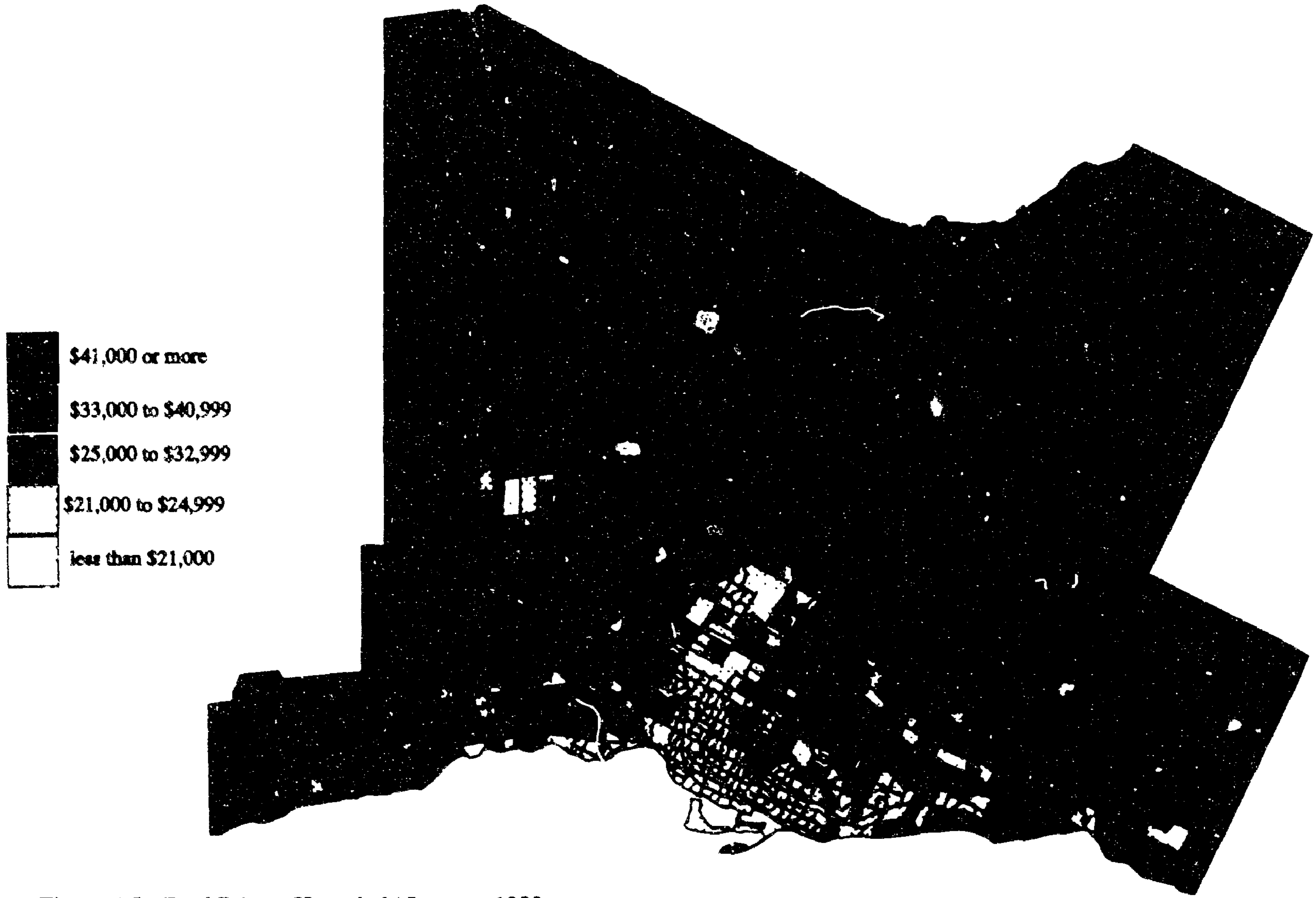

Figure 4.5: Total Private Household Income, 1980

Source: Statistics Canada, 1981

somewhat. There are some differences however. This raises the question of which variable is more indicative of economic wellbeing. The appropriateness of both measures is discussed in the Method section.

Figure 4.6 illustrates the concentration of population within the census metropolitan area of Toronto in 1981; Figure 4.7 depicts household distribution. These patterns must be considered when assessing the significance of estimated dwelling market value (or resale price), or private household income. The bulk of the population resided within the Metropolitan boundary and its immediate bordering municipalities. The effect of containment is especially evident along the northern boundary of the Metropolitan Toronto and in the mid Mississauga area to the west.

This pattern continues today, largely influenced by the common directives of the regional municipalities within the metropolitan region, their development approval processes and the provincial allocation of grants (Metropolitan Toronto Planning Department, 1990). These concentrations reinforce the dominance of Toronto in terms of location of households and residential development; the resultant effects of containment severely limit the degree of expansion in the surrounding areas. Further, they contribute to the justification of concentrating the study on the metropolitan unit.

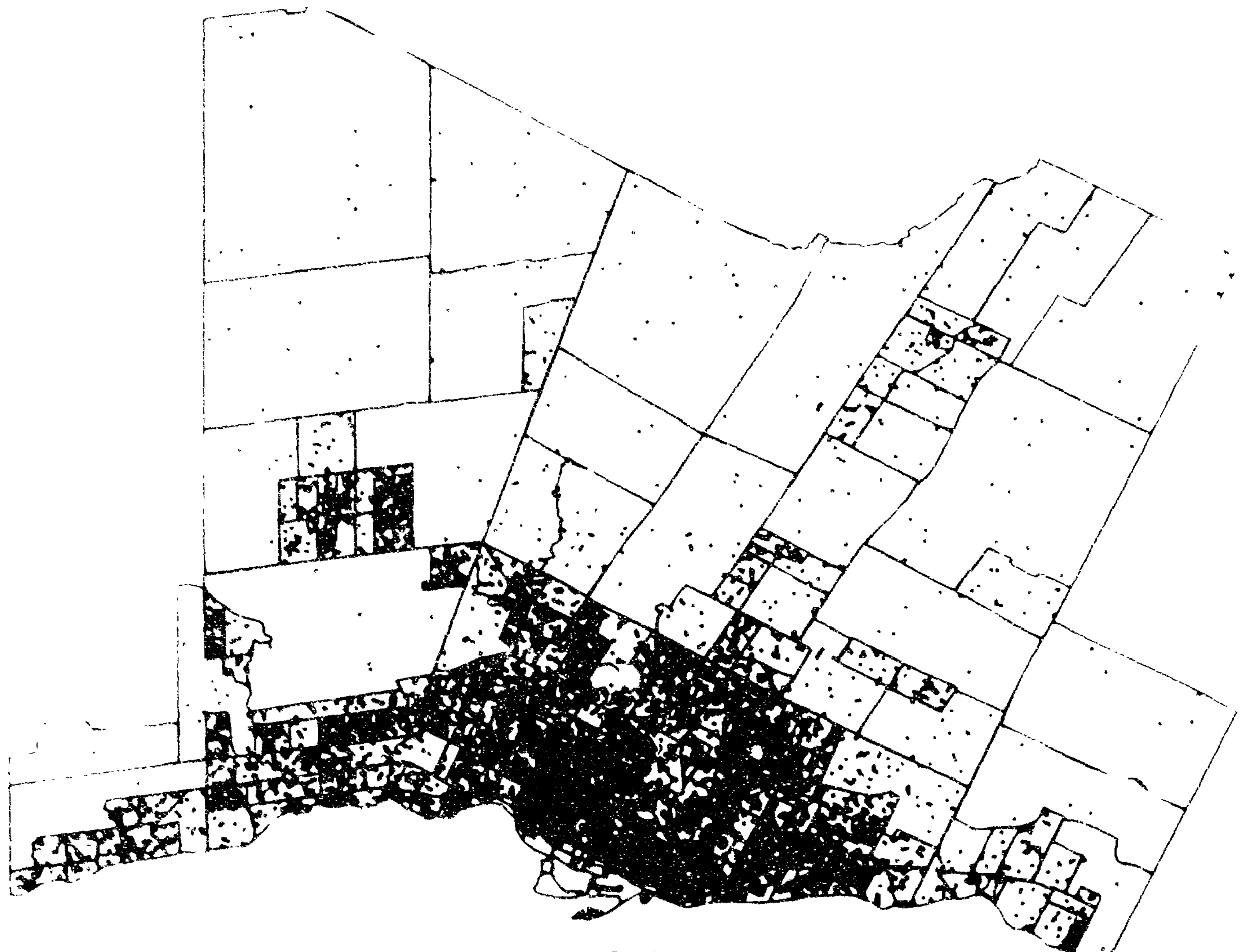

Figure 4.6: Population Distribution, 1981

One dot represents
500 persons

Source: Statistics Canada, 1981

Figure 4.7: Private Household Distribution, 1981

One dot represents
250 households

Source: Statistics Canada, 1981

The early drafts of the official plan for Metropolitan Toronto (1976, and 1978 for example) noted that it was essential for Toronto and the regional municipalities to provide for the development of a mix of type, tenure and price, with specific targets for moderate and lower income households. Further, the plan encouraged residential densities to be increased (Metropolitan Toronto Planning Department, 1978, 1989, 1990). This position was taken although suburban densities outside of Metropolitan Toronto were already higher than densities in other North American cities.

Historically there was (and still is) a definitive preference for single detaching dwellings in Ontario. Housing production in Metropolitan Toronto and the regional municipalities was dominated by this structural type from the mid 1980s (Canada Mortgage and Housing Corporation, 1980-1990). The continued high demand for single family houses, the high cost of land and the problems of affordability, resulted in revisions to municipal by-laws to permit higher densities of detached dwellings. This was achieved through reduced lot size. The parcelling of land into smaller lots in turn contributed to higher land values. From a planning point of view, while this increase in density was desired, the lack of variety of structural types was still a concern (Metropolitan Toronto Planning Department, 1987a). It is currently being proposed that single detached dwelling construction take place on smaller lots throughout the metropolitan region (Metropolitan Toronto Planning Department, 1990).

In light of the above, developers modified the designs of semi detached structures, linking them by their foundations (underground) only. This permitted satisfying the municipal requirements for this structural type, while marketing the dwelling on its above ground, single detached appearance. These "link homes" provided higher densities and needed smaller lots. However, their construction further reduced the building of lower priced forms of housing (such as the typical semi detached), and thus depressed that market segment to a greater extent (Metropolitan Toronto Planning Department, 1987a).

In accordance with Toronto's official plan, residential densities in subdivisions generally rose since the 1970s. The Metropolitan Toronto Planning Department (1987b) documented an increase from 26 units/hectare in 1977 to 37 units/hectare in 1984. Further, the number of single detached dwellings built also grew, reflecting the consumer preference discussed above.

High land costs in the Toronto region resulted in most of the new houses being constructed on lots approximately 50 feet wide and often as narrow as 35 feet (Metropolitan Toronto

Planning Department, 1987b). Thus, development that is peripheral to the metropolitan unit was (and is) built at higher densities than experienced within Metropolitan Toronto in the early post war years.

Further, the decline in availability of appropriate vacant land within the metropolitan boundary reduced the importance of new construction, in comparison with the volume occurring in the region. Any significant addition to the housing stock within Metropolitan Toronto will likely be the result of redevelopment or housing intensification (Metropolitan Toronto Planning Department, 1987a, 1987b, 1989).

It was recognized that any housing policy or strategy must be carried out on a regional level (Metropolitan Toronto Planning Department, 1989). The official plans of the regional municipalities of Durham and Halton, as well as that of the Metropolitan Toronto, recorded the intention to increase the level of densities of new housing, and to discourage estate development. The York and Peel regional governments are currently preparing their official plans. All of these governments indicate the same plan of action - increased residential densities, primarily through smaller lots.

It is now a directive from the Provincial government as well. Its recent policy statement on housing requires all municipalities in the region: to plan for their growth and demand in a regional context; to plan for a variety and mix of housing types; to ensure that at least twenty-five percent of new housing units are affordable; and to increase the supply of housing through better use of existing resources, buildings or serviced sites (Metropolitan Toronto Planning Department, 1989).

Over the past decade the greatest proportional increases in population in the region took place in the regional municipalities of Peel and York. By 1986, Toronto contained about 59 percent of the total population of the metropolitan region (Figure 4.8). Increasingly, much of the new growth is concentrated in the urban centers surrounding Metropolitan Toronto. The population figures listed in Table 4.2 illustrate the decline in the level of population growth by 1981 within Toronto, and the associated increment in the immediate urban fringe (defined as the municipalities of Pickering, Markham, Vaughan, Brampton and Mississauga):

TABLE 4.2: POPULATION CHANGE IN TORONTO AND ITS FRINGE, 1961-1986

	1961	1971	1981	1986
Metro	1,169,000	2,086,000	2,137,000	2,192,000
fringe	509,000	833,000	1,280,000	2,503,000

(Source: Statistics Canada, 1961-1986)

These municipalities, while dependent on Metropolitan Toronto for employment, are not entirely dormitory communities.

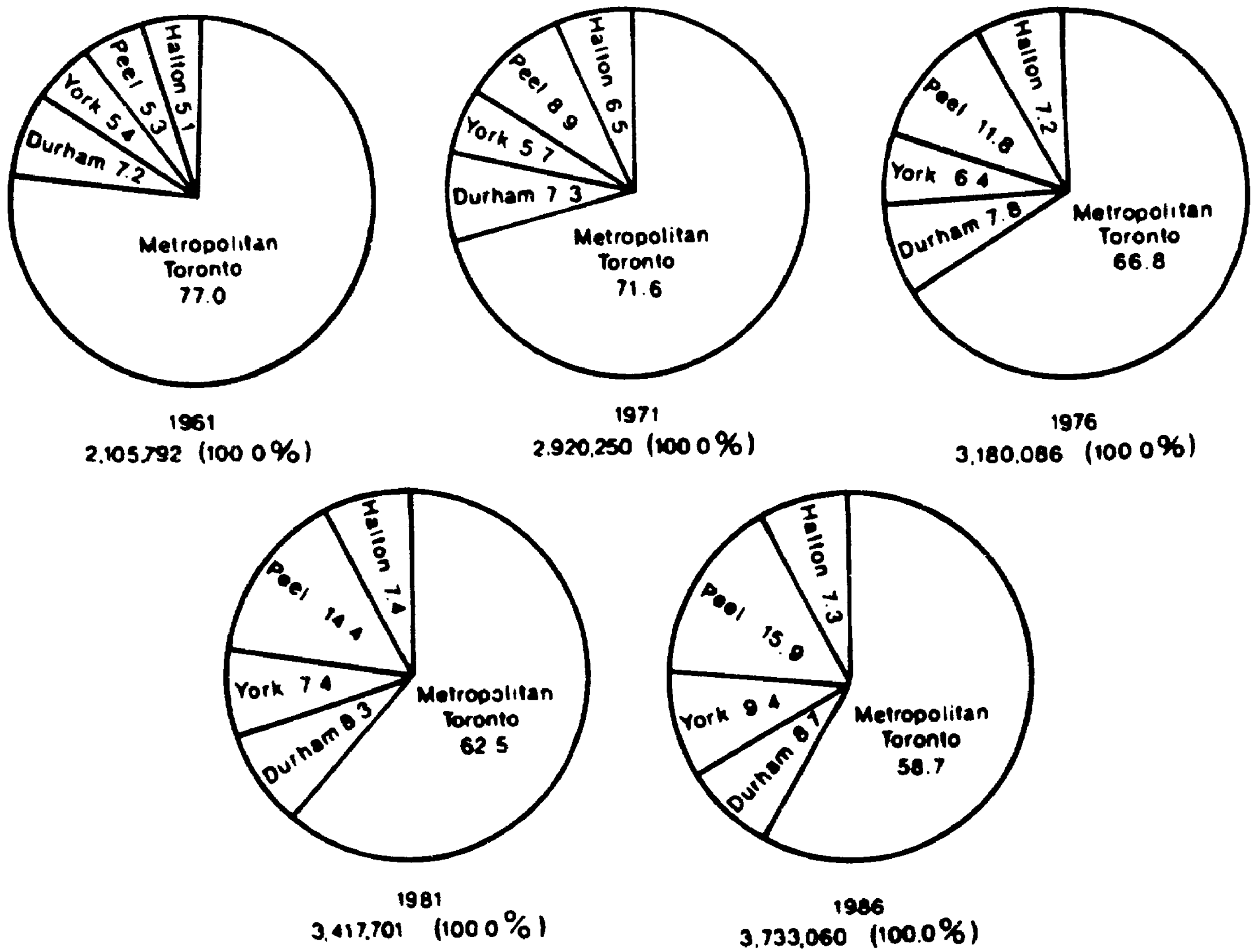

Figure 4.8: Population By Metropolitan Region, 1961-1986

Source: Statistics Canada, 1961-1986

Figure 4.9 illustrates the employment distribution in the Toronto CMA by census tract for 1981. Accompanying the population growth in the surrounding regional municipalities (discussed above), was a modest rise in employment. In 1981, Metropolitan Toronto contained seventy six percent of all the jobs in the census metropolitan area; by 1986, this proportion fell to sixty five percent (Statistics Canada, 1986). Still, the bulk of the jobs were located within the metropolitan unit or in its immediate fringe.

This is not meant to suggest that employment declined within Toronto. In fact, when viewed in light of the locations of recent residential development i.e. in the surrounding regional municipalities, Metropolitan Toronto held 12 percent more jobs than its resident labour force. Further, this imbalance is projected to increase (Metropolitan Toronto Planning Department, 1990)[12]. This has implications for increased in-commuting and traffic congestion.

Figure 4.10 contains an employment profile for the Toronto census metropolitan area for 1985. The service sector dominated the regional economy and provided over seventy percent of the jobs. The goods producing sector (manufacturing, construction and "other") was responsible for

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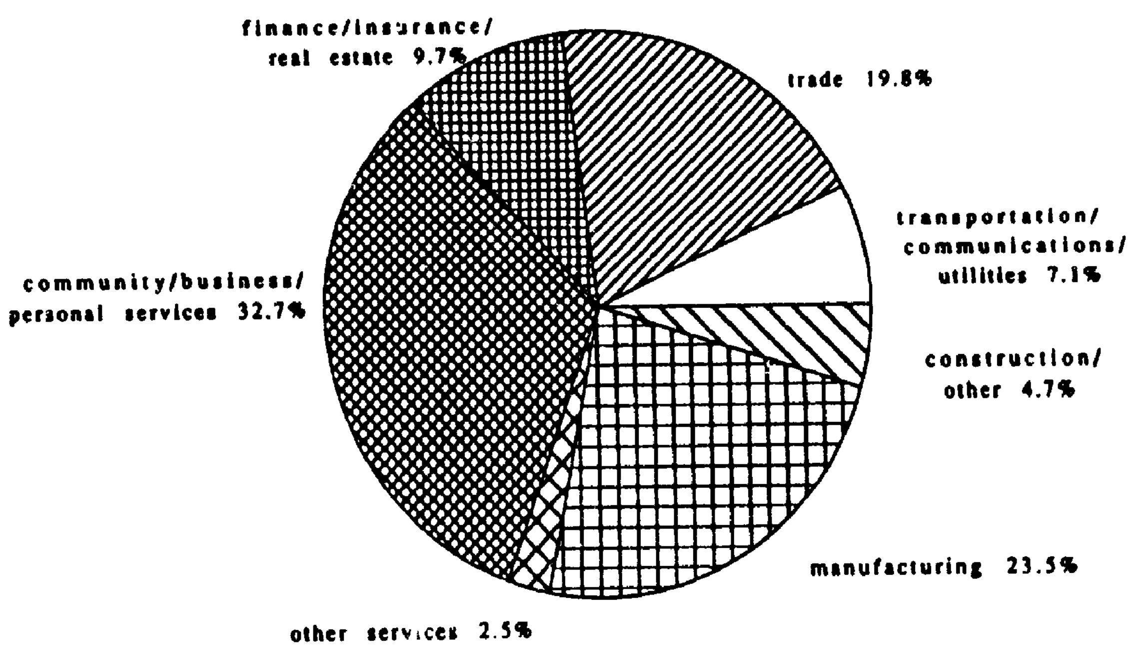
[12] For example, the aging of Metropolitan Toronto's population will contribute to a greater inequality over time.

Figure 4.9: Employment Distribution By Location, 1981

Source: Statistics Canada, 1981

Figure 4.10: Employment Distribution by Industry, 1985



Source: Statistics Canada, 1985

about 28 percent of all employment. Any significant growth in this sector is projected to occur in the regional municipalities (Metropolitan Toronto Planning Department, 1990).

The service sector was (and is) the fastest growing component of the regional economy. Accompanying this was a significant shift of office space to the older suburbs since 1980. This was evident in the planned suburban downtown centers of North York, Scarborough and Mississauga (the latter being outside Metropolitan Toronto)[13]. Despite this decentralization, office space continued to be concentrated in the City of Toronto. Metropolitan Toronto accounted for around 88 percent of the total office space in the metropolitan area. Suburban office growth is increasing and is encouraged in the official plan, but much of the projected development is expected to be within Metropolitan Toronto.

This has implications for job destinations, levels of attractivity and related accessibility. The growing concentrations of employment within Metropolitan Toronto (albeit not in the core) keeps the areas of highest accessibility within the metropolitan unit as well. This has a potential impact on the revaluation of residential space, especially when combined with trends in lot size.

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[13] Three other fringe cities are now emerging contributing to a greater polycentric urban form.

Accompanying this rise in residential development in the fringe area was a continued adjustment of political relationships. The Toronto Area Liaison Committee (TALC) was formed in 1981 to coordinate interregional planning and transportation in the Toronto region, and to provide a forum for regional municipalities. This included Metropolitan Toronto, and the regional municipalities of Durham, York, Halton, Peel and Hamilton-Wentworth.

Later, Metropolitan Toronto and the surrounding regional municipalities joined to resolve waste disposal problems. The resulting Greater Toronto Area committee may lead to some cooperative form of "neo-regional government", to tackle servicing, housing and accessibility related problems. In 1987 the Government of Ontario created the Greater Toronto Coordinating Committee to coordinate and support regional planning decisions across the Greater Toronto Area (GTA). This was composed of Metropolitan Toronto and the regional municipalities of Durham, York, Peel and Halton (see Figure 4.3). The Provincial government also established the Office of the Greater Toronto Area to coordinate and support regional planning decisions across the GTA.

Coincident with the changes in the fringe over the past twenty years was the redevelopment of large sections within the City of Toronto. Typically, these changes involved civic, office, luxury condominium and apartment developments.

The end result was a downtown with the highest intensities of retail and office employment in the Toronto CMA (Gad, 1986). It also had one of the highest population densities in North America (around 6000 people/sq. kilometre). Housing in the downtown area became extremely expensive, and recent growth was almost solely in the realm of luxury condominium development. Gentrification in the surrounding inner city was (and is) popular (Filion, 1987; Ley 1988). This created problems of affordability in the City comparable with those experienced in the suburbs.

Gentrification and redevelopment now extend beyond the CBD's adjacent areas, further depleting moderate price housing (Ley, 1988). The economic pressure to capitalize on well located sites is extending past the older gentrifiable neighbourhoods and is affecting the post war suburbs (Metropolitan Toronto Planning Department, 1987a; Relph, 1990).

The desirability of better located, lower density areas is resulting in the demolition of smaller post war houses (typically 1200 square feet) on larger lots in the older suburbs, and their replacement with considerably larger single detached homes (3,000 - 4,000 square feet). These new dwellings are out of context with the existing neighbourhood, are expensive to service, and are difficult to subdivide or convert[14]. Recently, a few municipalities passed bylaws (such as North York in 1988 and 1990) to restrict some of the more excessive schemes. These trends may reflect the lack of available lot space in the periphery, due to the planning directives and policies that are in place to increase residential densities.

Thus, three levels of government are currently involved in planning the Greater Toronto Area:

- the Province, through its statutory approval of all regional and local plans;
- the five regions, including Metropolitan Toronto, who have the mandate to prepare regional official plans; and
- the thirty area municipalities, including the City of Toronto, who have local planning control.

Currently, the Metropolitan Toronto official plan is under review to incorporate regional issues. In addition, the Provincial Ministry of Transport is examining proposals for extensions of expressway/subway/commuter rail systems into the immediate fringe areas. At present, nearly two-thirds of all trips generated within the Greater Toronto Area have an origin or a destination in Metropolitan Toronto (Metropolitan Toronto Planning Department, 1990).

The "Greater Toronto Urban Structure Concepts Study" (IBI Group, 1990: iii) recommends "containing sprawl and promoting

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[14] Thus, these also run contrary to the planning directives for housing intensification and increasing residential density (Metropolitan Toronto Planning Department, 1987b, 1989).

the intensification of urban land uses". Concurrent with this, the Metropolitan Toronto Planning Department report (1990), entitled "GTA: concepts for the future", advises minimizing unnecessary land consumption and encouraging densities high enough to support transit. These increased densities, to be realized throughout the Greater Toronto Area, are to be achieved by concentrating on medium density developments - specifically (considering the nature of recent demand and demographic projections), smaller single detached dwellings on smaller lots (Metropolitan Toronto Planning Department, 1990: 46, 55). This means significant densification. At present, Metropolitan Toronto has a density of 3500 people/sq. kilometre, while the remaining region contains 2100 people/sq. kilometre; the optimal density for transit efficiency is 4000 people/sq. kilometre (with a 3000 people/sq. kilometre minimum).

The current and future directives on residential density have significant implications for differential revaluation of residential space. When this containment of growth is combined with the emergent employment trends, the continuation of previous intraurban income distribution patterns becomes suspect.

CHAPTER 5:

METHOD

5.1 Introduction

The fundamental thesis of this dissertation is that limitations on residential space consumption at the urban perimeter (exemplified by lot size constraints) result in a revaluation of space and access by the household. It is postulated that, for lots with comparable levels of accessibility, the degree of relative revaluation will rise with increasing residential space - basically, the larger the lot size, the larger the relative increase.

The model examines the household's choice of relative residential location within a metropolitan center. The decision is achieved through utility maximization subject to budget, accessibility and space constraints. Assuming that each household desires the best living conditions that it can afford, the selection of the site and situation is clarified to the combination of residential space, relative location, a composite good and income. The model is empirically tested through the application of the appropriate data for the representative variables involved, and the comparison of the predicted arrangement with the actual intraurban income distribution. Descriptions of data characteristics, variable measurement, testing procedure and geostatistical unit definitions are presented below.

5.2 Characteristics of the Data Base

5.2.1 Justification of the Venue:

Metropolitan Toronto is an appropriate case study venue for examining the fundamental premise of the dissertation. It is the largest urban center and the major financial node in Canada (Code, 1975; Lorch, 1981). Land and housing costs are among the highest in North America. Its urban growth is continually subjected to planning and development controls; increasingly, these take the form of space consumption constraints.

Public planning for growth is taking place on a greater scale including areas outside of the political boundary of Metropolitan Toronto. This spatial extent, labelled as the Greater Toronto Area, is considered to represent the bulk of Toronto's influence on land use. It includes numerous smaller cities and towns, open space and agricultural lands.

Thus, the use of Metropolitan Toronto as the politically bounded setting and full study area does not, in reality, represent the full spatial extent of the total housing market. Related fringe development is occurring at sixty to seventy kilometres away (and perhaps farther) and the potential commuting zone extends over 100 kilometres[1] .

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[1] Proposals to extend the GO train commuter rail line west to the town of Woodstock would potentially extend the Toronto commuting range as far as two hundred kilometres. However, this has not been implemented and would represent

However, limitations in data availability (discussed below) restrict the study area to the metropolitan unit.

This is not considered to be a significant drawback for a number of reasons. The extended fringe components are limited in their size and volume. Accordingly, the bulk of the development outside of Toronto has been located in the immediate fringe communities (due to various planning directives, approval constraints, the strength of the Toronto core, etc.)[2]. This development has, for the most part, occurred since the early 1970s, placing it under the influence of the same broad planning policies that have guided residential growth within Metropolitan Toronto. In addition, a significant portion of the expansion during this decade took place within the metropolitan unit (Toronto was recognized as being "almost fully built up" in 1978). New single detached developments in the 1970s (and later in the 1980s to a degree) within Metropolitan Toronto are reflective of those built at the same time in the immediate fringe, due to their evolution within similar planning and market environments, for the most part. Thus, peripheral development within the metropolitan limit should correspond to that just outside this political boundary. This supports

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only a small fraction of the actual Toronto housing market.

[2] This development concentration is mirrored by the spatial extent of the market area of the Toronto Real Estate Board: it includes Metropolitan Toronto and the immediate fringe area only.

the use of 1971 as the base year (in most cases) for the investigations of percent change and other temporal analyses. Lastly, any revaluation of relative location by a household will likely result in a change within Metropolitan Toronto, as this is the main venue of the older suburban large lot developments, and the primary "container" of improved accessibility (although this improvement is not ubiquitous).

5.2.2 Units of Measurement:

In contrast to many U.S. cities, the increasingly comprehensive planning controls that evolved in Metropolitan Toronto (and many Canadian centers) following World War II decreased the sale of individual lots to buyers. The subdivision became the unit for residential development (Gallion and Eisner, 1975; Spurr, 1976). This unit was subject to the market conditions, planning and development constraints present at the time of construction. The combination of these actors created conditions that are unique to that time period and location, and resulted in an area of housing that is homogeneous with respect to other subdivisions in the metropolitan area.

The degree of internal heterogeneity, however, creates a problem for analysis. The presence of high rise apartments and other higher density dwelling types in many subdivisions built since the late 1960s, and often required for planning approval, reduces the usefulness of this spatial unit for empirical examination.

The utilization of the block as an areal study unit permits the reduction of the problem of dwelling mix while removing the possibility of concentrating on the individual anomalies that may exist within it. Further, it reflects the character of the subdivision at the time of development. The value of a specific home is influenced by its immediate surroundings and these are reflected in this development unit i.e. the block.

To collect appropriate information pertinent to the block level, assessment rolls are the primary data source. From the individual residential/household unit, block totals are aggregated. Metropolitan Toronto has (or is in the process of creating) computerized records of assessment information, combined into structurally-predetermined data bases.

The primary sources of information are the "Regional Planning File" (1988) and the "Housing Data Bank" (1988) for Metropolitan Toronto, maintained by the Metropolitan Toronto Planning Department, and the Census of Canada (Statistics Canada, 1961-1986). The standard unit of aggregation used by the Planning Department is the "Basic Planning Unit" (BPU), defined as a representative and homogeneous unit. The arrangement of BPUs within Metropolitan Toronto is highly analogous to the arrangement of census tracts[3]. This permits the comparison of planning information with census information at these levels. While not presenting an exact spatially bounded copy in all cases, the near duplication allows comparison of trends with a high degree of proficiency[4].

The block level is deemed to be the ideal unit of measurement because it allows for the consideration of neighbouring properties in establishing data levels. The model deals primarily with the intraurban distribution of higher socioeconomic groups within a potential land consumption constraint environment. Thus, home ownership and space-extensive residential developments are important characteristics of the category of greatest concern. To permit the exclusion of the obvious forms of rental accommodation (such as apartments) and to concentrate on the structural types of lower residential density and space consumption (i.e. the reduction of condominium, row, semi detached, duplex and mobile housing from the study area) all blocks containing fewer than ninety percent single detached

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[3] A comparison of the number of BPUs (1988) and census tracts (1986) by political unit is listed below:

	Toronto	York	E.York	N.York	Etobicoke	Scarborough
BPU	147	30	18	73	58	92
CT	149	30	21	111	67	91

[4] In almost all cases, any difference in polygon size is simply overcome by aggregating the appropriate smaller units to correspond with the larger BPU or census tract.

dwellings are excluded. One block (satisfying the ninety percent criterion) within each possible BPU within Metropolitan Toronto is selected. If a choice exists, the block which has the fullest data complement and is closest to the geographical center of its BPU is selected.

To enable the comparison of census data with the block level data, the enumeration area is used. While this census unit is larger than the individual block, limiting a direct alignment of areal unit, it is contended there is no significant misrepresentation. The typical enumeration area used contains four to six blocks. Any distortion of the appropriate enumeration area data attributed to a specific block is softened by the averaging that occurs in the calculation of the enumeration area mean value (of which the specific block in question is included). Thus, the greater possibility may be in underrepresenting the severity of an anomaly, due to the mollifying effect of averaging, than creating an extreme scenario. The pairing of block and enumeration area units is achieved through the comparison of the appropriate census maps (showing all streets and blocks) and BPU maps (containing the same).

5.2.3 Problems in Data Collection:

The major problems in data collection were the availability and manipulation of the computerized assessment roll records[5]. The difficulty lay in accessing the files and selecting only the information required. This function was performed by a government office (the Metropolitan Toronto Planning Department, in this case) and was not open to the individual researcher. As the computer format was a recent one, downloading from the Main Frame system, selectively removing appropriate variables and aggregating them consistently proved to be a significant obstacle. When combined with job prioritization for computer time, the repeated collection of data proved to be an arduous task. Further, the required purchase of this computer time was financially demanding, creating logistic difficulties for the researcher.

Some of the fringe communities were also in the process of computerizing records. Unfortunately, this resulted in different information sources not being available at the time of data collection (in either computer form or the actual assessment rolls). The end result was the limiting of the analyses to Metropolitan Toronto.

Another limitation with regard to data collection lay in the completeness of the data base. There are 418 Basic Planning Units in Metropolitan Toronto. When the ninety percent

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[5] Due to computerization, the actual assessment rolls are not available.

single detached dwelling criterion was applied to the block selection, the number of represented BPUs was reduced to 245. Almost all of the excluded BPUs were located within the City of Toronto[6]. For the 245 BPUs concerned, floor area measures by block were available. However, site area values were incomplete, limiting the number of appropriate spatial units (i.e. those with a full data complement) to 117. Attempts at reducing the criterion for selection to eighty-five or eighty percent single detached dwellings per block did not improve the number of available blocks, due to differing data gaps.

Despite these problems and limitations, the data base is representative of the trends occurring within Metropolitan Toronto. Figure 5.1 illustrates the distribution of the Basic Planning Units represented by the block data. It is argued that due to the dispersion, the overall pattern within Metropolitan Toronto is well portrayed. The only area that is modestly underrepresented lies in the southern half of Etobicoke. The larger gaps along the periphery are due to the presence of the Pearson International Airport, the C.F.B. Downsview Airport and the Metropolitan Toronto Zoo (west to

[6] This concentration is logical, considering that the City of Toronto contains the metropolitan central business district, many areas of high residential density, active redevelopment (mostly high density condominium and non-residential uses) and the site of historical transportation components, such as the extensive rail yards and piers. These all serve to limit the occurrence of single detached dwelling-dominated blocks.

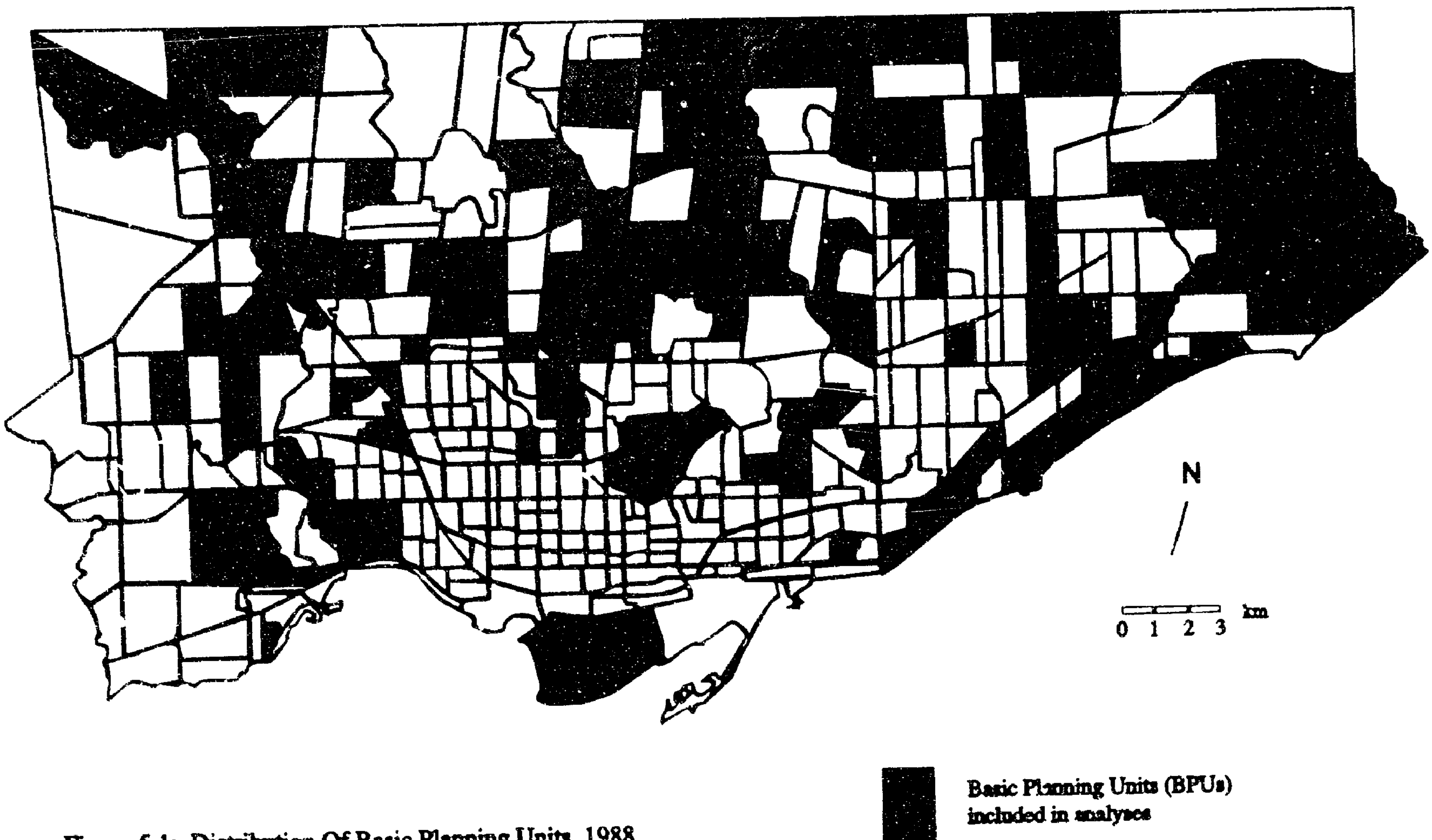

Figure 5.1: Distribution Of Basic Planning Units, 1988

east, respectively). Further, the quantity of blocks provides an adequate base for statistical analyses.

5.3 Measurement of Variables

To explore the predicted income distribution of a population within a metropolitan center, a land consumption constraint is incorporated into a utility maximizing household budget equation. Four main variables are identified in this equation: household income, a composite good expenditure, a housing expenditure, and a transportation expenditure. The latter two reflect the relative accessibility of the location in question. The measurements of household income, relative accessibility and the three types of expenditure are outlined below.

For each of these variables, measurement is based on the individual private household/property and aggregated to the block level or enumeration area level. A private household refers to a person or group of people who occupy a dwelling as their usual place of residence (Statistics Canada, 1987). The household is considered to be the appropriate unit of measurement (versus the individual) because it is the collective body that makes most expenditure decisions. Further, it reflects the consumption oriented approach (Bourne, 1990).

5.3.1 Household Income:

The theoretical level of income required to live at a certain location is predicted by the model. To test the validity of the model, actual income is measured in two ways: private household income, and estimated market value of the home. These two variables, while complementary to a degree, compensate for limitations found in each individually. Data for private household incomes and estimated dwelling market values are based on block-corresponding enumeration areas, tabulated from the Census of Canada Machine Readable Data File for 1986.

The private household income for a specific location is defined as the mean total income of households in 1985. The total income of the household is the sum of the total incomes of all members of that household (Statistics Canada, 1987).

A number of possible limitations arise from using this variable as an indicator of economic wellbeing. There are weaknesses concerning how household income is defined. The largest portion of personal income is derived from employment (about 80%), with the remainder comprised of government transfers and "other varied sources" (Economic Council of Canada, 1990). This latter category, "other varied sources", is difficult to measure yet is growing quickly (Bourne, 1990). Further, the reliability of census data to be representative of economic level is worsened by the sources not considered to be income, such as the transfers of money and services, inheritances, the underreporting of capital, wealth accumulation and expected or future income (Bourne, 1990; Bossons, 1978).

When a household moves to an urban area and behaves rationally in their housing choice (by maximizing utility subject to a budget constraint), the market value of the residential selection is commensurate with the household's income (current and permanent), capital accumulation and wealth. Therefore, when evaluating the potential income level required to live at a certain location, the market value of the home is an appropriate subrogate. The estimated market value of a home for a specific location is defined as the dollar amount expected by the homeowner if the dwelling were to be sold (Statistics Canada, 1987).

The use of this measure avoids some potential pitfalls inherent in relying strictly on existing household income, such as: the presence of residents who have frequently moved through increased equity in the properties such that they are able to locate in an area that would normally be beyond their financial means; retired households who, while financially secure, operate on incomes below their previous levels; the presence of land speculators whose decisions are based on anticipated future market conditions rather than current values; or the location of households through methods other than market purchase (such as familial ties).

There are potential drawbacks in using this variable as an indicator of economic status. Demographic and lifestyle shifts could potentially decrease the value of a housing unit to below that which is predicted because of changing demand. For example, the continued trend toward smaller families has lessened the demand for five and six bedroom homes. While these units would appear to be premium in terms of floor space and potential lot size, the lessened demand may create a depressed market value.

Analogous to this, the fluctuating price structure of moderate condominium row housing over the last two decades reflects, among other things, changing tastes and life styles. Such economically irrational decisions are difficult to incorporate into a simplified model, yet nonetheless affect the housing market. Ethnic and racial considerations, actual levels of servicing and offsite amenities are obvious contributors to dwelling value, but may reflect unique situations. Similarly, singular housing submarkets, trends in architectural preference, and so on, may temporarily distort the perceived market worth of a home. Finally, the values are based on the owners' perceptions of market worth.

5.3.2 Composite Good Expenditure:

Theoretically, this expense is held at the level where its marginal utility is equal to that of the housing expenditure[7]. This allows higher income households to consume more or better goods and services than lower ones, but the level of consumption does not reduce the relative spending on housing. In effect then, the location decision results from the relationship between housing costs and transportation costs at that location. This follows on the logical progression of Alonso (1964), Muth (1969) and Gera and Kuhn (1977).

5.3.3 Relative Accessibility:

The measurement of accessibility continues to be subjected to different approaches (Bederman and Adams, 1974; Koenig, 1980; Williams, 1988; Gordon, Richardson and Jun, 1991); yet, recent modelling attempts (Thrall, 1987) often return to using distance from the city center, akin to the work of Alonso (1964) and others. In order to (i) incorporate the changing location patterns of non-residential uses in today's urban structure, and (ii) still maintain a proven (yet simplistic) measure, relative accessibility is calculated in two ways: employment potential and distance from the core. These two measurements are appropriate for polycentric and monocentric urban structures (respectively). While these two measures could be highly correlated, such as in the case of a CBD-dominated center, it is hoped that one will prove more

[7] This assumption is similar to Muth's (1969) equilibrium conditions.

appropriate. The use of an employment potential calculation gives greater consideration to the distribution of jobs (and thus attractions), and provides a more sophisticated (and replicable) method than simple measurement of distance from the core. The use of distance is of interest, however, for its simplicity, its historic (and continued) use in the literature, and because of the lack of agreement on a better indicator.

For the first measure, accessibility is operationalized to a calculation of employment potential (Equation (4)) for a specific location relative to all other locations. A high potential represents a greater degree of accessibility afforded by the site in question. The calculation of employment potential requires the measurement of employment at each location, and distance between each location and all others. These measurements use the Basic Planning Unit (BPU) as the spatial unit of concern. Employment values are based on the total 1988 employment in each BPU, according to the values listed in the Regional Planning File. Distance is measured from the geographical centroid of each Basic Planning Unit, to the midpoint of all other BPUs. Calculation of the employment potential for a specific BPU requires four records for each of the 418 lines of data needed: origin (the BPU in question), destination (each BPU, including itself, one at a time), employment (at the destination), and distance (between origin and destination)[8]. Derivation of the relative levels of employment potential for all BPUs in Metropolitan Toronto involves almost 175,000 lines of data and nearly 700,000 records. This calculation permits the consideration of potential polycentricity. The resultant pattern is discussed in Chapter Seven and shown in Figure 7.12.

The second measure of relative accessibility is the distance from the Central Business District to the centroid of each BPU. This is in keeping with Alonso's theoretical approach and much of the land rent modelling literature. The resultant pattern is compared with that of employment potential in Chapter Seven.

Each approach is based on the Basic Planning Unit as the relevant spatial unit. The accessibility value for the appropriate BPU is applied to the block in question. It is assumed that any distance between the block location and the geographic centroid of the BPU is minimal and insignificant.

The two accessibility calculations (employment potential and distance) require separate iterations of the model. This permits the evaluation of these two measures and provides insight into the factors of household location.

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[8] When measuring distance to itself, i.e. the same BPU as origin and destination, the distance function equals one.

The contribution of relative accessibility to required household income (and thus housing market value) is determined through the calculations of the housing and transportation expenditures. A high relative accessibility theoretically reduces the corresponding transportation expenditure, and increases the demand for such locations. This increase in demand is suggested to result in higher per unit housing costs[9].

5.3.4 Housing Expenditure:

Housing expenditure is determined by the amount of housing consumed. If increased demand occurs with greater accessibility, resulting in higher per unit costs, this infers that site area consumed will usually be less with increasing accessibility, for a certain income level.

Furthermore, if accessibility is not directly related to nearness to the core, it suggests that availability of increasing site area with increasing distance from the core will not necessarily hold true. This will also result if land constraints have been placed on new or recent developments, limiting these site areas to levels below those of previous growth.

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[9] This is supported by the work of Thrall and Feather (1987) who examine distance, population density and land value and concurs in principle with the negative rent gradient put forth by Alonso and others.

Measurement of the quantity of space consumed enables the inclusion of density constraints in the empirical testing of the model. The availability and purchase of a large lot or more space is represented without the assumption of land quantity increasing with distance. Instead, the effect of suburban land constraints on household location are analyzed. This housing quantity is measured in three ways: site area, floor area and a composite measure of site and floor areas. Each measurement requires a separate iteration of the model. This permits evaluation of the three measures of housing quantity and improves the assessment of the components of residential development that are most affected by land constraints.

The two forms of information detailing areal quantity are based on data from the Housing Data Bank. The spatial unit used for the quantity calculations is the block.

The site measurement provides the average site area for the block in question. This value permits the direct consideration of land space as a separate part of the housing bundle.

The floor area measurement is the average floor space of the dwellings within the block in question. With the increasing trends of larger homes on moderate and small lots, the great reduction of side yards, the return to multistorey dwellings and the changing density of suburban developments historically, this measure permits the examination of the dwelling component as a separate entity. Realistically it is not totally separate, because the site space constrains the extent of ground floor space.

The third measure is an average of the relative sizes of site and floor spaces. To achieve this, all absolute site measures are calculated to relative values ranging from a maximum of 100 to the appropriate minimum. The same manipulation is performed on floor measures. Then the two values, now given equal weight, are averaged to provide a relative combination value ranging from a maximum of 100 to the appropriate minimum. This provides a composite value reflective of the fundamental housing bundle i.e. land and dwelling. It too is an average of the values aggregated to the block level.

5.3.5 Transportation Expenditure:

This variable is identified in Equation (3) as the commuting cost incurred at a certain location. Cost is a function of accessibility, such that a greater relative access results in a lower transportation expense at that site.

Commuting cost, determined by the distances travelled to various attractions (such as employment, shopping, etc.) is site specific and directly related to the accessibility of that site. The assignment of a relative commuting expense to a location is based on the accessibility of that location and is achieved through measures of the accessibility values calculated for each Basic Planning Unit. These values are based on the two approaches mentioned previously. The first method involves the calculation of the employment potential for each BPU; relative commuting cost is considered to be the inverse of the calculation. The second calculation involves the measurement of the distance from the CBD for each BPU; relative commuting cost is considered to be directly proportional to this measurement.

5.3.6 Actual Dwelling Value

To facilitate the description of the spatial and temporal trends in actual dwelling values in Metropolitan Toronto, the average estimated dwelling market value is tabulated at the census tract level. This is collected for the years 1961, 1971, 1981, and 1986 from the Census of Canada. The variable is defined as the amount expected by the owner if the dwelling were to be sold (Statistics Canada, 1987). From these values, the percent change over time is calculated, for different time frames. Both dwelling value and the percent change in value are mapped for the years listed above.

To permit a more precise comparison of actual values with the model's predicted values, the 1986 estimated dwelling market value is also tabulated at the enumeration area level.

Further, the 1986 enumeration area and census tract patterns are juxtaposed. This is done to determine any major deviations and to evaluate the applicability of the census tract-based trends to the model's predictions.

5.4 Empirical Testing Procedure

The bulk of the mapping categories used are based on a common procedure. The average and standard deviation for the full number of cases are calculated. Those spatial units which have amounts in excess of the average or those with less than the average indicate relative high and low areas (respectively). These two broad categories are subdivided to provide a finer pattern. This subdivision is based on the addition (for above average areas) or subtraction (for below average locales) of (a) one and (b) two standard deviations. The final categorization consists of 5 divisions. The actual data ranges within each category vary from map to map, depending upon the variable and time frame, but the method of calculation remains the same. The five categories are listed below:

(1) greater than +2 standard deviations
(2) +1 standard deviation (plus *) to +2 standard deviations
(3) average to +1 standard deviation
(4) average to -1 standard deviation
(5) less than -1 standard deviation
* is the minimum amount of measurement used in that data set i.e. for dwelling value it is 1, while for percent dwelling value change it is .01

It is suggested that these calculations allow concentration on those areas of immoderate value or immoderate percent change in value, while still presenting the overall distribution. Thus, the representation is relative to the conditions at that time, and not strictly an illustration of absolute values. Concentrating on these statistical categories of value or change permits comparison with the other maps, in light of the fact that the actual data ranges and time frame may vary.

The descriptions of the spatial and temporal trends in dwelling value in Metropolitan Toronto from 1961 to 1986 are performed using census tract level data. These data are illustrated using Basic Planning Units (BPUs). The BPU is identical in almost all cases to the census tract boundaries of 1971 through 1986. Where it is not, this problem is solved by aggregating either BPUs or census tracts. There are discrepancies with a few of the 1961 boundaries, but it is suggested that the distortion is limited, and not a factor in discriminating general spatial and temporal trends. Further, the bulk of the temporal analysis is performed using 1971 as the base year. In addition, the use of the BPU-based map facilitates the comparison of the trends identified from the census data with those from the Regional Planning File and Housing Data Bank. This provides a consistent base for discerning the fundamental patterns over time. This spatial consistency also contributes to an improved representation of the information concerned. Lastly, it is the spatial and temporal trends, and not the singular or unique case, that are of concern here.

Two procedures are employed in manipulating the data for description. The first involves the mapping of dwelling values for each of the census years of 1961, 1971, 1981, and 1986. The second requires the mapping of the percent change in dwelling value from one census period to the next. The data are presented in a form which expresses relative value, and not absolute value. This is done for a number of reasons. Within a specific year, the interest lies in distribution of more expensive versus less expensive dwellings. The actual or absolute values are not as important as the relative arrangement. In the comparison of different years, or the percent change between time periods, it is the variation or consistency in the pattern that is of concern. The use of absolute values clouds this correlation, in that the actual dollar amounts will be different, even though the relative scenario may be the same. This could be overcome by converting all absolute values through a consumer price index to reflect a specific base year. Doing this, however, takes away the use of the actual number, and places it in a relative format as well. Further, the use of relative values will permit the comparison of different cities, regardless of the absolute values of their housing markets. Thus, the approach (and model) becomes generic and more widely applicable.

Based on the patterns of dwelling value, six sectors are distinguished. These sectors are similar to those identified in earlier research[10]. The inclusion of a sectoral perspective permits the appropriate statistical analyses to be based on individual sectors as well as the full study area. The results are discussed in the section entitled 'Empirical Analysis I: Description of Trends'.

Next, simple linear regressions and variable plots are performed on all possible combinations of the variables[11]. This is done to test for obvious correlations between the variables and to explore the distributions of the data. Following, multiple linear regressions and scatterplots are performed on the possible combinations to examine the distributions of data and regression results. Data transformations are explored in an attempt to overcome problems of heteroscedasticity.

The results of these regressions and tests lead to the performing of weighted least squares multiple regressions on

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[10] The identification of sectors based on economic status has been studied since the seminal work of Hoyt (1939). Analyses involving more sophisticated approaches, such as those employing social area analysis or multivariate analysis, reinforce the notion of the sectoral form of economic status distribution in a city. Of greater relevance to this study is the Murdie's (1969) factorial ecology application to Metropolitan Toronto.

[11] All statistical procedures were accomplished using SPSS PC+ ver. 4.0. Data manipulations were accomplished using Lotus 123 rel. 3 and SPSS PC+ ver. 4.0.

the possible combinations of the variables in the model. The relative accessibility value used (employment potential or distance) is suggested to be the most appropriate weight variable. First, it influences (theoretically) the housing expenditure and/or availability. Second, it shows the greatest degree of heteroscedasticity, compared to the housing consumption variables. Performing the weighted least squares multiple regression allows the model's performance to be evaluated, based on the various combinations of the variables, while treating the study area as a whole. The most appropriate variables are identified, based on their performance in the different iterations of the model.

This statistical technique is also performed on the six sectors discussed earlier. The variables used are based on the preceding tests. These sectoral analyses provide greater insight into the spatial relationships that may be hidden when the study area is treated as an entity. The analyses of these statistical examinations are found in section 'Empirical Analysis II: Applications of Regression Techniques'.

Based on the results of the weighted least squares multiple regressions, the appropriate variables for the distinct iterations of the model are selected. Specifically, the dependent variable that proves most pertinent (estimated dwelling market value or private household income) is included with the most suitable gauge of accessibility (distance from the core or employment potential). These two variables are combined with the second independent variable - the space measure. Space is evaluated in three ways: relative site area, relative floor area, and a composite area measure. These space "yardsticks" are individually combined with the dependent and independent variables listed above.

Each combination requires a separate iteration of the model. The result is three sets of predicted relative dwelling value/required income estimates. These three sets are individually mapped. Each resultant spatial arrangement and its internal distribution (by standard categories) is assessed against the pattern of the actual dependent variable. This provides an additional method of evaluating the representativeness of the model, through a spatial context.

Lastly, the fundamental thesis concerning the relationship between accessibility, site area and revaluation is tested. If peripheral containment is causing a revaluation of existing sites, it follows that within areas of similar accessibility, larger sites will have experienced a greater relative value increase than smaller ones.

To examine this, cluster analyses are performed at two different levels of detail, for each of the accessibility variables. The applications provide (i) five and (ii) ten categories or groups of cases. This is done in the effort that major relationships may be identified, and not obscured due to level of aggregation. The following table lists the number of clusters specified in the procedure for each accessibility variable, and the ensuing number of groups of cases. These quantities may be different because some of the resulting groups were merged to the most appropriate adjacent ones if the number of cases in these groups did not satisfy the necessary minimum size requirement (of five pairs of observations per group), set out in the assumptions for the Spearman's rank correlation coefficient (Norcliffe, 1982).

TABLE 5.1: SPECIFIED CLUSTERS AND RESULTANT CASES

accessibility variable	# of clusters specified	# of groups of cases
distance from the core	5	5
distance from the core	15	10
employment potential	7	5
employment potential	15	10

Once the clusters of cases with similar accessibility are established, (i) site area and (ii) percent value change (1971-1986) for each block are ranked in order of magnitude within each cluster category. The time period of 1971-1986 is selected for the calculation of percent dwelling value change. While the initial examination of dwelling values includes 1961, there are some boundary changes in the 1971 data set. This limits effective statistical analysis at the enumeration area or census tract level. The number of differences between 1971 and 1986 do not pose the same problem. In almost all cases, simple aggregation provides for identical geostatistical units. Further, these units are near mirror images of the Basic Planning Units identified by the Municipality of Metropolitan Toronto. In addition, the long period (as compared to 1981-1986) should avoid the shortcomings possible in a shorter time frame, such as short term market fluctuations due to the economy, the existence of temporary submarkets, etc.

The strength of the association between the relative rankings within the category in question is measured using the Spearman's rank correlation coefficient. The significance of this association is assessed by computing the value of t, and determining its significance through a table of critical values (Siegel, 1956).

This procedure is also applied to the study area as a whole, with all ranked cases from each cluster combined into one data set. This is done to help expose any notable difference between the two levels of detail.

The use of ranks allows the comparison of the intragroup relationships between the clusters, where each cluster has "largest" to "smallest" site areas and value changes, despite absolute values. It also permits the hypothesis testing of the relationship in more simplistic terms. These statistical procedures, and the results of evaluations of the predicted values of the model, are analyzed in the section labelled 'Empirical Analysis III: Predicted Value Distributions and Cluster Analysis'.

5.5 Geostatistical Unit Definitions

Information from the "Regional Planning File" and the "Housing Data Bank" is collected at the block and Basic Planning Unit levels. The block is a spatial area enclosed by neighbouring and intersecting streets. Based on the selection criterion of percent dwelling type, it is considered to be internally consistent.

The Basic Planning Unit, as mentioned earlier, is defined by the Metropolitan Toronto Planning Department as a homogeneous and representative unit. This homogeneity does not necessarily refer to dwelling content. These spatial units are almost identical to census tracts.

Census of Canada data are from the enumeration area level and the census tract level records. Based on the definition used by Statistics Canada (1986), the enumeration area is defined according to the following criteria:

(i) Households - the number of households in an enumeration area generally varies between a maximum of 375 households in large urban areas to

> a minimum of 125 in rural areas; (ii) Limits - an enumeration area, being the building block of all geostatistical areas, never cuts across any geographic area recognized by the census. Moreover, enumeration area boundaries are defined such that the Census Representative will be able to locate them with as little difficulty as possible, for example, streets, roads, railways, rivers and lakes.

This is the smallest geostatistical level available for the census information required. While it is somewhat bigger than the block level, its physical continuity and relatively small size may contribute to internal homogeneity.

Data concerning general trends in dwelling value in Metropolitan Toronto, used in the discussion of the patterns of actual dwelling value and its temporal percent change are based on the census tract unit because of its comparability to the Basic Planning Unit. The criteria used by Statistics Canada (1986) is as follows:

> (i) the boundaries must follow permanent and easily recognized lines on the ground; (ii) the population must be between 2,500 and 8,000 except for census tracts in the central business district, in industrial areas, or in peripheral rural or urban areas which may have either a lower or a higher population; (iii) the area must be as homogeneous as possible in terms of economic status and social living conditions; and (iv) the shape must be as compact as possible.

The application of the methods discussed above are analyzed in the following chapters.

CHAPTER 6:

THEORETICAL ANALYSIS

6.1 Introduction

An individual or household wishes to select a home. This involves several decisions concerning the amount of space wanted (house area and lot area) and the desired degree of proximity to various functions and attractions (including employment). In reality, the household would consider many other aspects (school requirements, ethnicity of the neighbourhood, age and quality of the dwelling, nearness to friends and relatives, etc.) and would not have full and equal knowledge of all areas of the city.

In accordance with the assumptions of the model, the individual or household is assumed to behave rationally (in an economic sense) and have perfect knowledge. Simplifying the consumer(s) in this way allows the household to be treated as an entity (instead of a collection of potentially different desires and tastes - and thus satisficing at best) and permits typical or general desires (versus unique or singular) to be considered. The concern here is not for how these desires are fashioned but what they are.

Further, higher income households are the primary consideration. Theoretically, these entities have superior purchasing power and thus get to select their location and housing bundle first, or at least outbid lower income groups.

The central premise of this examination is that new or recent lots, existing for the most part at the periphery of the built up area, are subject to significant density constraints, limiting lot sizes to less than previously allowed. This creates a scenario that is radically different from existing urban models, and forces a revaluation by upper income households.

In order to obtain greater lot space, there are two main options. First, the household may consider locating at a much greater distance from the city, in effect leapfrogging the area "under restriction", and incurring greater commuting costs. Second, the household may reconsider a larger lot that is within the built up area and bid above its "current value", leading to a change in the income profile of the city.

For consumers with similar levels of income, the two alternatives discussed above may also involve a reassessment of the value of accessibility. They may trade off the desire of more space for a location with similar space (as that available at the periphery) that provides greater access or proximity to various functions and attractions (i.e. a move "inward"). Conversely, households may opt for more space that is available only at much greater distances from the center, sacrificing accessibility to the city to a large extent.

In sum, lot size constraints at the periphery may force a revaluation of space and/or a revaluation of accessibility. The fundamental concern of this research is for the households that choose to live within the built up area, and not those which reside at the edge of the commuting range. These are the households that contribute directly to the socioeconomic structure of the city, and may create a different intraurban income profile from that explained by the current urban literature.

While it is acknowledged that the households which choose to live at long distances from the core to obtain greater space affect the socioeconomic profile of the city by their absence, it is suggested that such conditions are typical of earlier urban structure. The bulk of the literature on urban morphology as well as that dealing with economic and theoretical considerations purports that higher income groups live at the edge of the city.

What is of most interest here relates to the degree of importance of those households who may be "breaking the mould" of the traditional intraurban socioeconomic profile, when faced with the new considerations of space restrictions and accessibility value. To simplify and examine the potential patterns resulting from space constraints, the individual variables outlined in the model will be discussed diagrammatically.

6.2 Land Price

It is assumed that land price decreases with decreasing accessibility[1]. This is essentially true for cities with vibrant cores, and is akin to land price declining with distance from the CBD. It is also applicable to centers with significant suburban nucleations. In this scenario, land price declines with decreasing accessibility from each nucleation (Erickson and Gentry, 1985).

The general relationship is shown in Figure 6.1. Based on this cost structure, when a certain location is chosen, it carries with it a certain price. This correlation does not necessarily imply a distance from the core, only an association between accessibility and land price. This fundamental relationship is, however, purported to exist anywhere in the urban realm. While the actual levels of price may change, the pattern does not.

6.3 Accessibility

The selection of a certain location implies a certain cost of transportation expense. Areas of high accessibility to attractions (employment, shopping, recreation, culture, etc.) result in lower transportation costs, while lower accessibility results in greater costs. Four situations are

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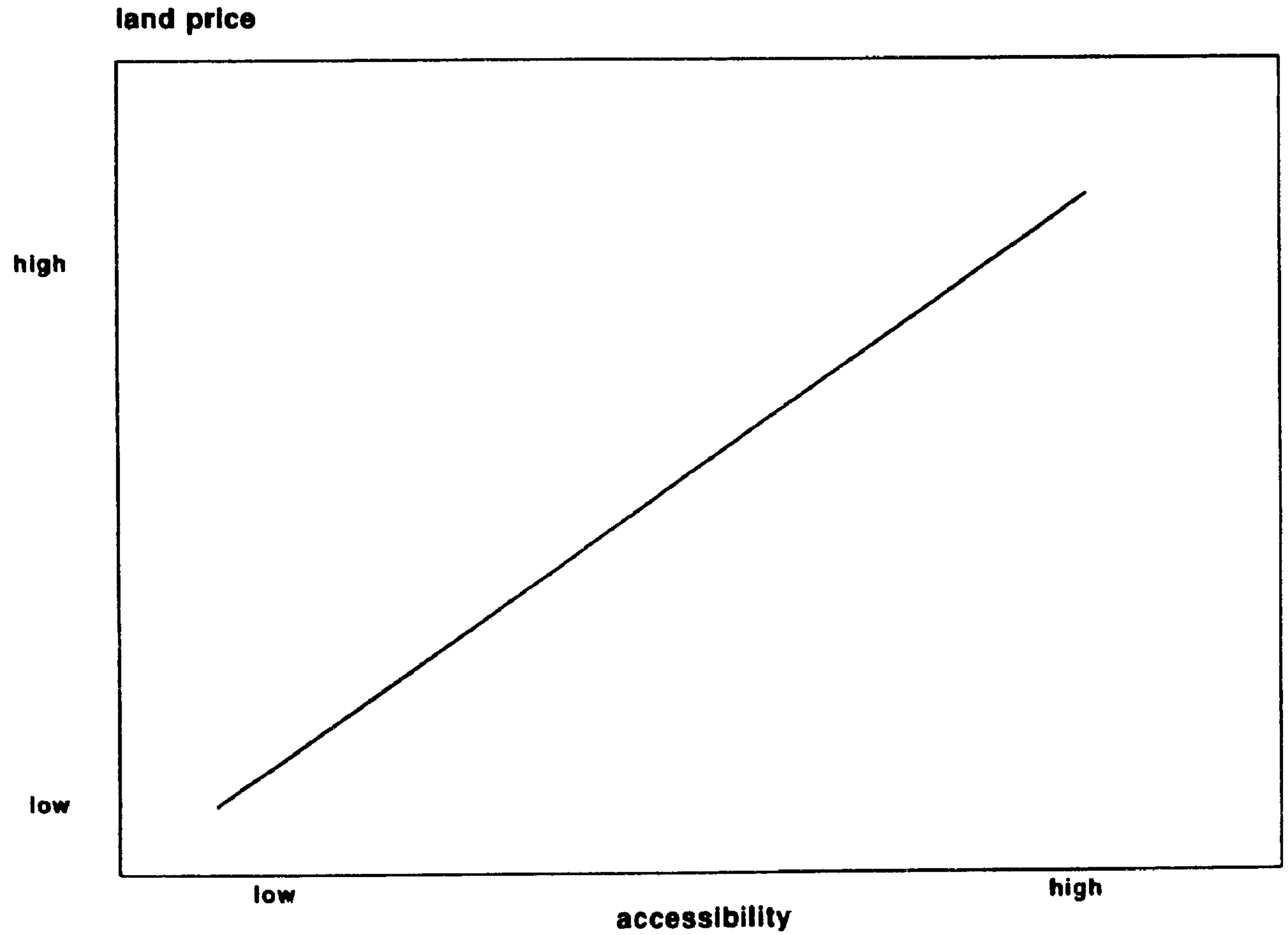
[1] This is fundamental to the work of Alonso (1964), Mills (1972), Muth (1969), and others. Further, it has supported by Thrall (1987), Grieson and Murray (1981), Landsberger and Lidgi (1978) and others.

Figure 6.1: The Relationship Between Land Price and Accessibility



described below.

The first case has all attractions located at the core, resulting in accessibility declining with distance from the core (Figure 6.2a). The second case considers all attractions to be at the periphery, such as would be the case with suburban concentrations only (Figure 6.2b). This creates a profile that is the reverse of the previous one.

The third situation reflects equal concentrations of attractions in the core and at the periphery (Figure 6.2c); accessibility increases with increasing proximity to each node. Finally, the fourth case represents a dispersion of attractions throughout the built up area such that no one location has any significantly greater access (Figure 6.2d).

Each of these four scenarios provide the spatial or relative location component that is not addressed in the discussion of the first relationship (i.e. land price). Varying degrees of each or combinations of the scenarios listed above may be present in the urban center at a particular time.

6.4 Land Quantity

In addition to choosing a location, the household must decide on the quantity of land it would like. It has been established that the price of land decreases with decreasing accessibility. Thus, for a set income, the quantity of land

Figure 6.2: Potential Relationships Between Accessibility and Distance

Figure 6.2a

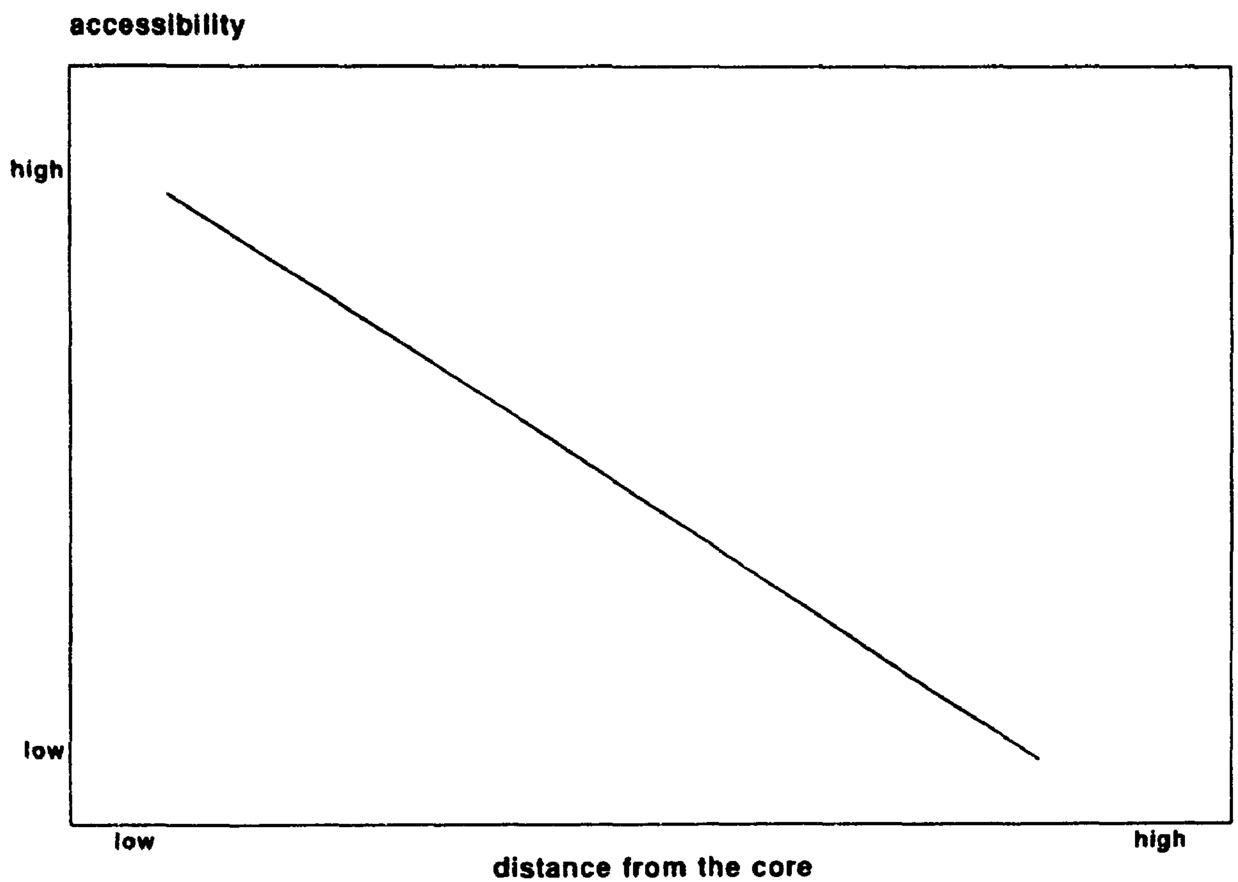


Figure 6.2: Potential Relationships Between Accessibility and Distance

Figure 6.2b

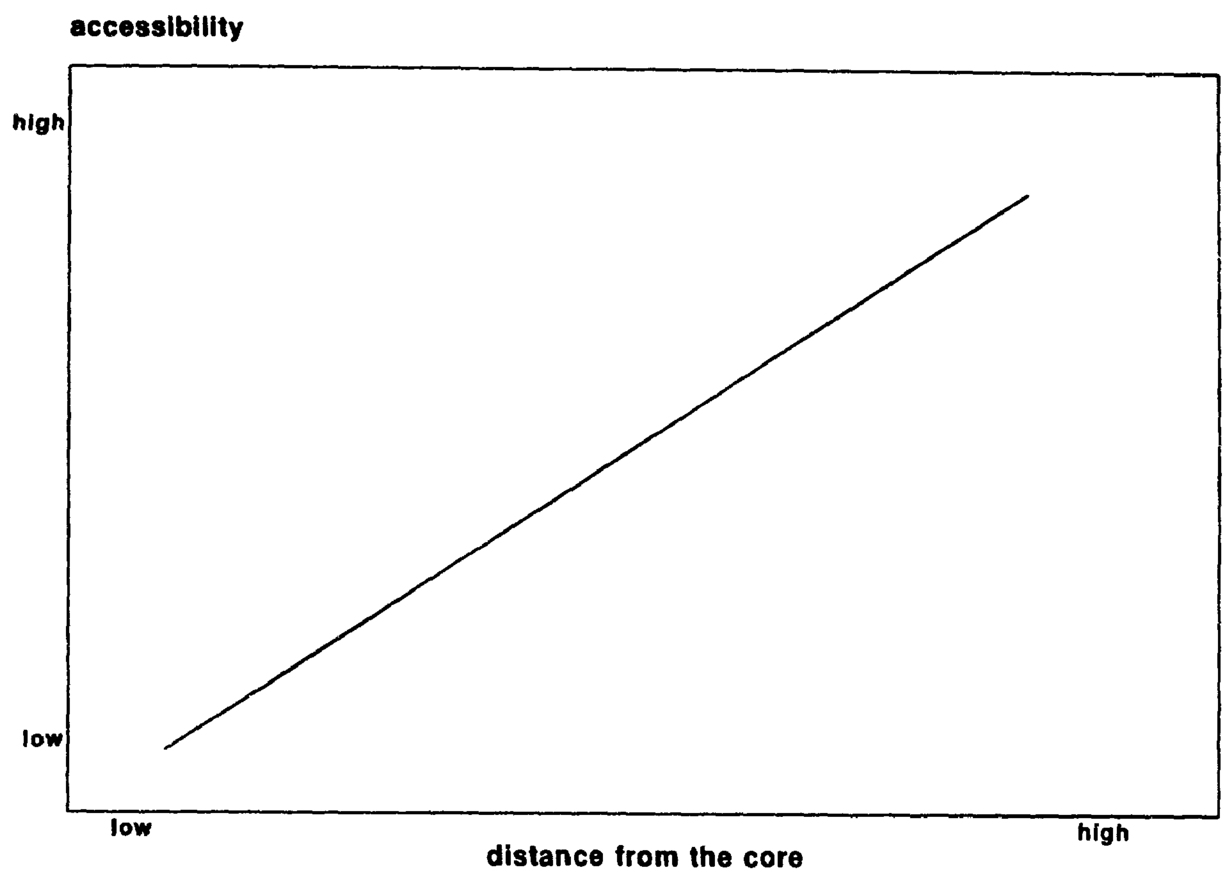


Figure 6.2: Potential Relationships Between Accessibility and Distance

Figure 6.2c

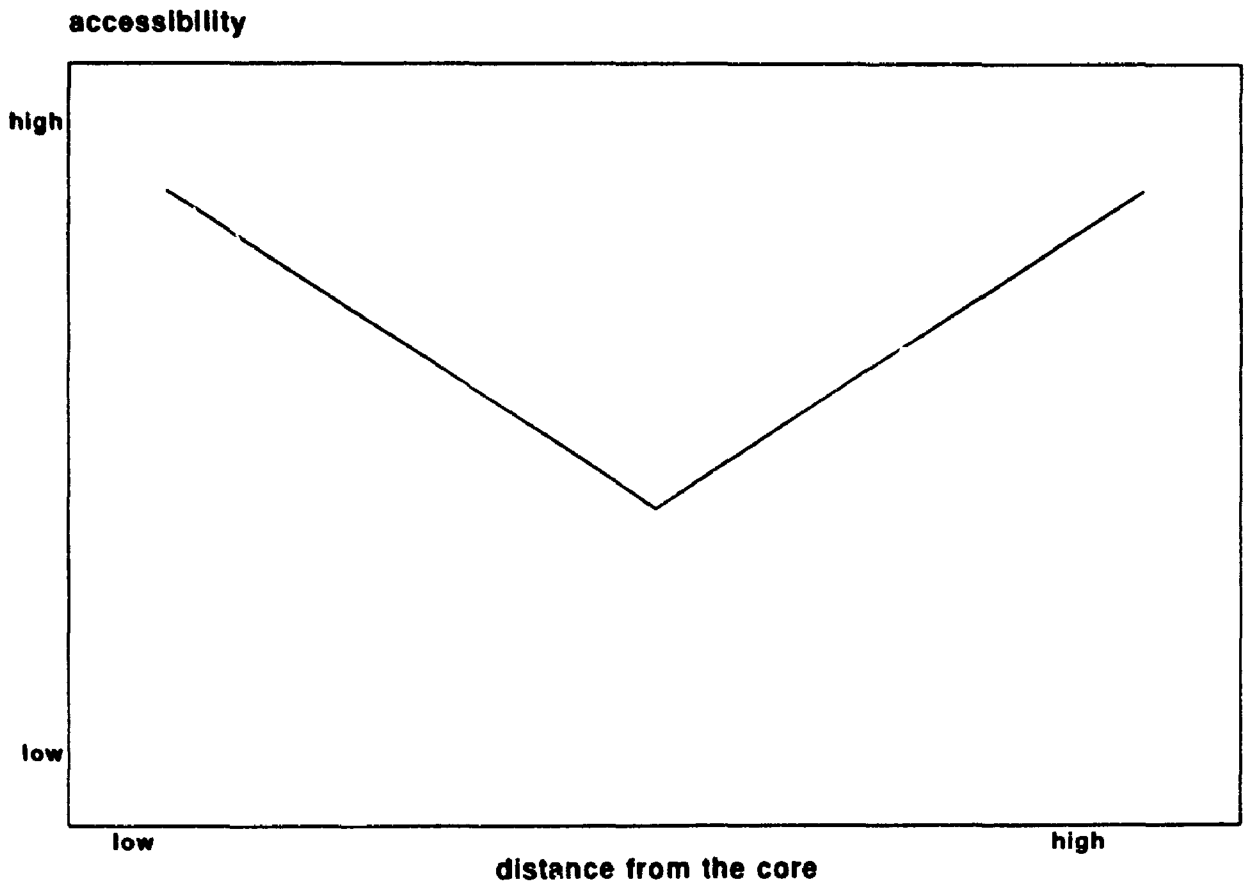
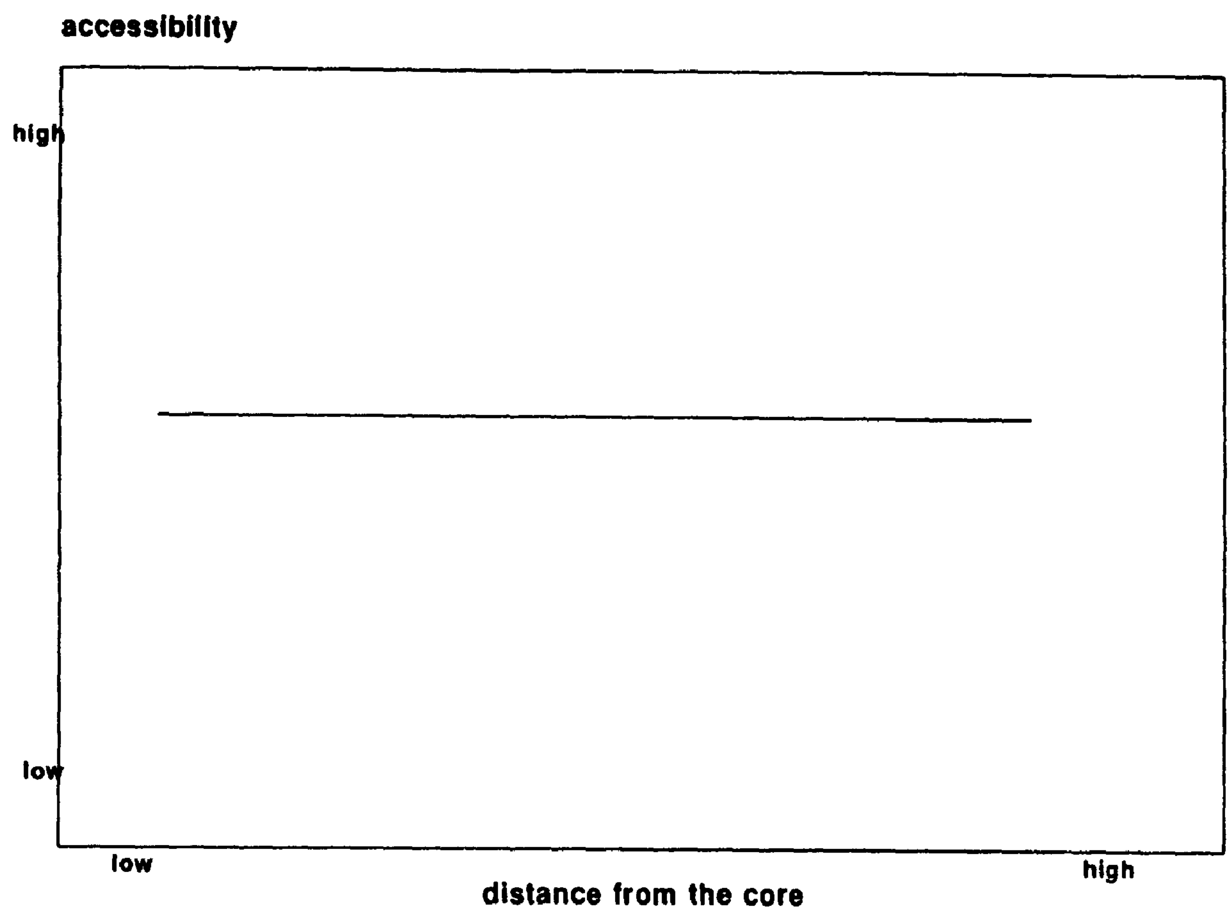


Figure 6.2: Potential Relationships Between Accessibility and Distance

Figure 6.2d



that may be purchased will increase with lower accessibility (Figure 6.3a). However, accompanying lower access levels are greater transportation costs. As discussed earlier, the resultant locus of opportunities curve (Figure 6.3b) is the consequence of marginal increases in transportation costs and declining land prices.

When lot size is restricted to the previous or less than the previous size, the graph of potential land quantity and accessibility changes (Figure 6.4a). Consequently, the saving from decreasing land price is reduced, restricting the greater expenditure in transport cost. The net result is the selection of a relative location that has greater accessibility (Figure 6.4b).

6.5 Income

The above discussion is based on one income level. When all incomes are considered, certain patterns should appear. If there are no restrictions, it is expected that the higher income groups would select locations farther from the node (CBD or suburban nucleation) to purchase as much land as possible (i.e. the point where the increased saving in land price equals the marginal increase in transportation costs). If the center is monocentric, the pattern would be typical of that discussed in the literature: greater incomes with increasing distance from the CBD (i.e. decreasing accessibility). The relationship is depicted in Figure 6.5a.

Figure 6.3: The Relationship Between Land Quantity and Accessibility

Figure 6.3a

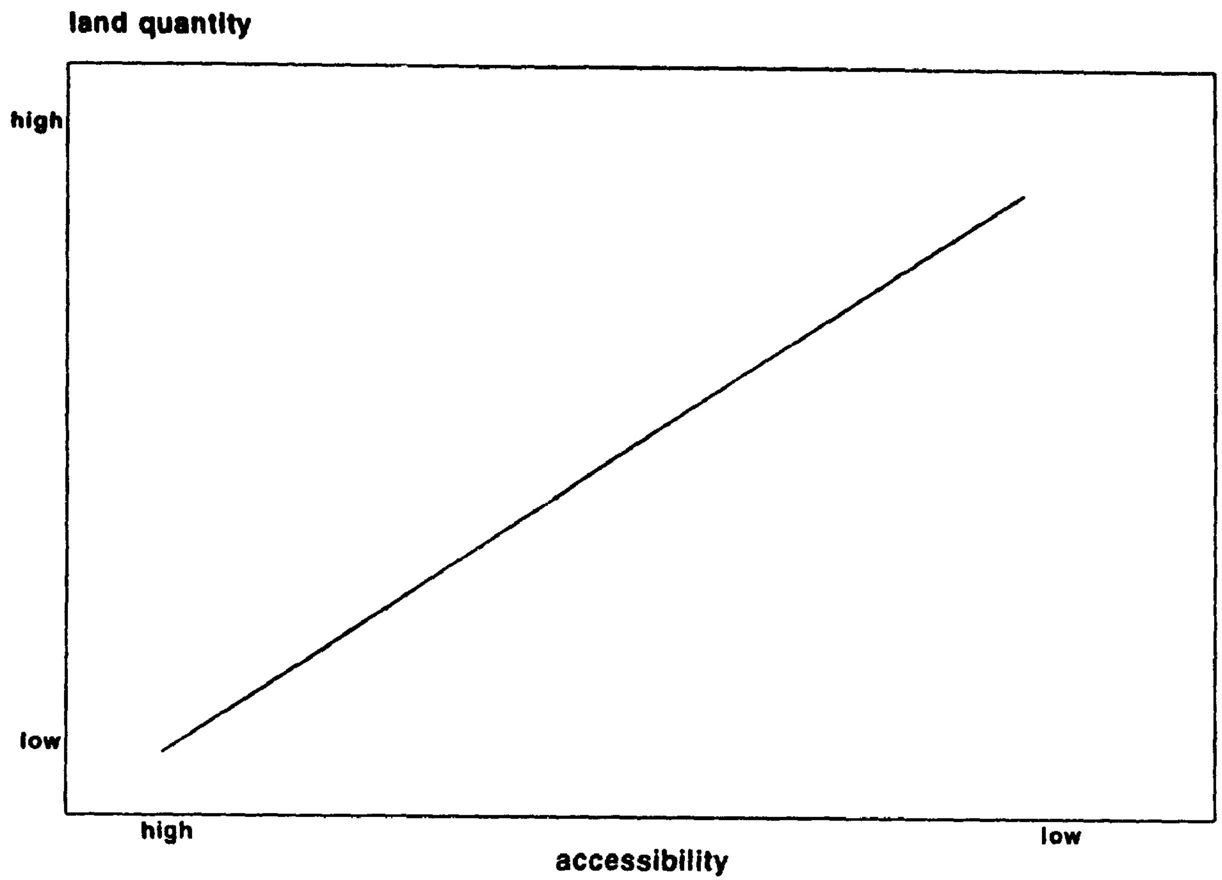


Figure 6.3: The Relationship Between Land Quantity and Accessibility

Figure 6.3b

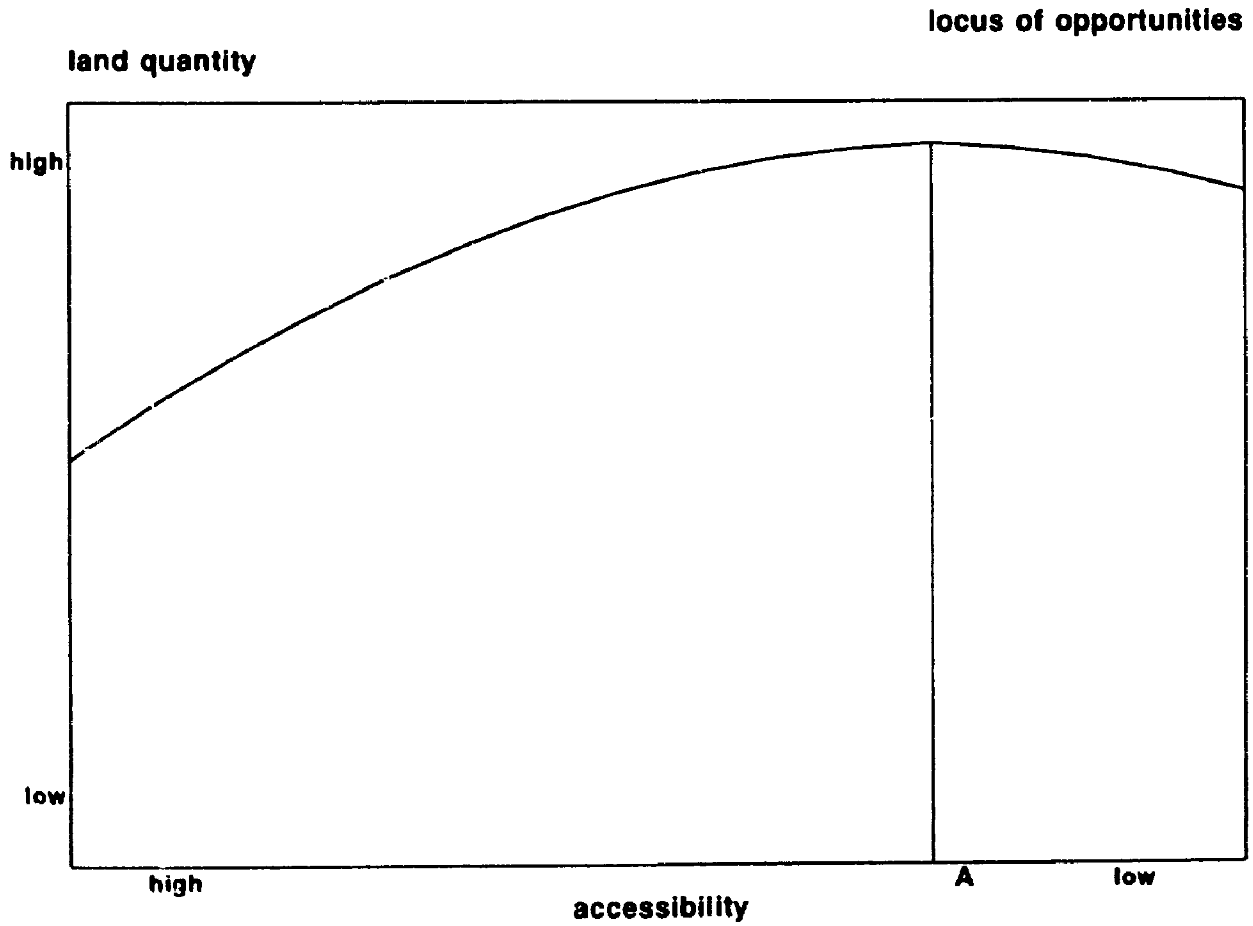


Figure 6.4: The Effect of Land Quantity Constraints

Figure 6.4a

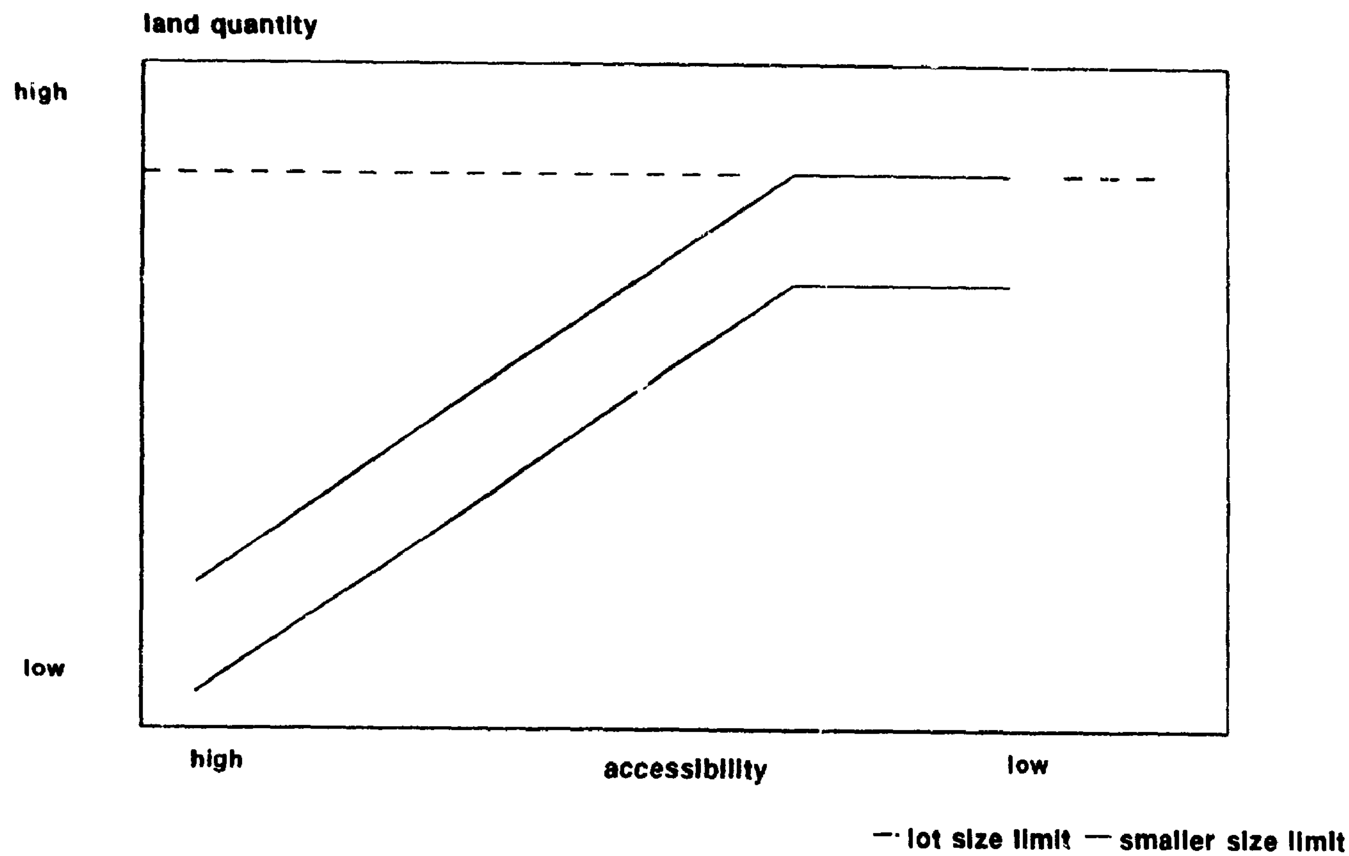
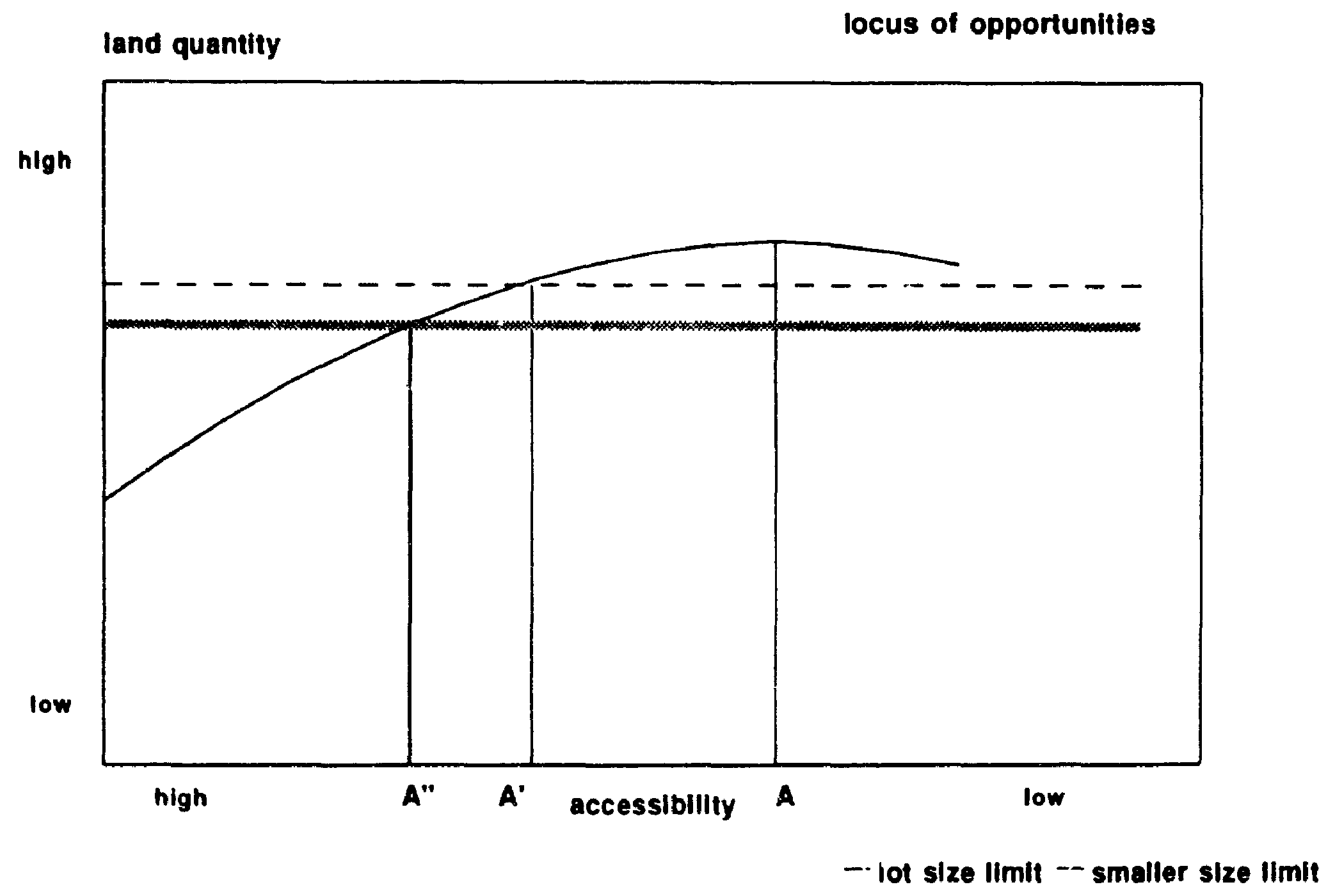


Figure 6.4: The Effect of Land Quantity Constraints

Figure 6.4b



If nucleations exist the pattern becomes more complicated (Figure 6.5b). In the simplistic scenario, income is expected to increase with decreasing accessibility from the node (or CBD). However, as the presence and size of nodes and their areas of influence (on accessibility) change and overlap, the picture becomes complex. The principle pattern still remains the same (Figure 6.5c), with smaller repetitions of it occurring where additional nodes exist.

When lot size restrictions are introduced, income increases with decreasing accessibility to the point of restriction, and declines thereafter. Existing larger lots rise in relative value, due to the lack of availability of new comparable space. Similarly, older locations with lot sizes similar to the new restriction increase in income due to the revaluation of accessibility (Figure 6.6).

The combination of these theoretical relationships, appropriate to Metropolitan Toronto, provide the basis for the model and for the empirical assessment of its real world applicability. The latter is discussed in the following sections.

Figure 6.5: The Relationships Between Income and Accessibility

Figure 6.5a

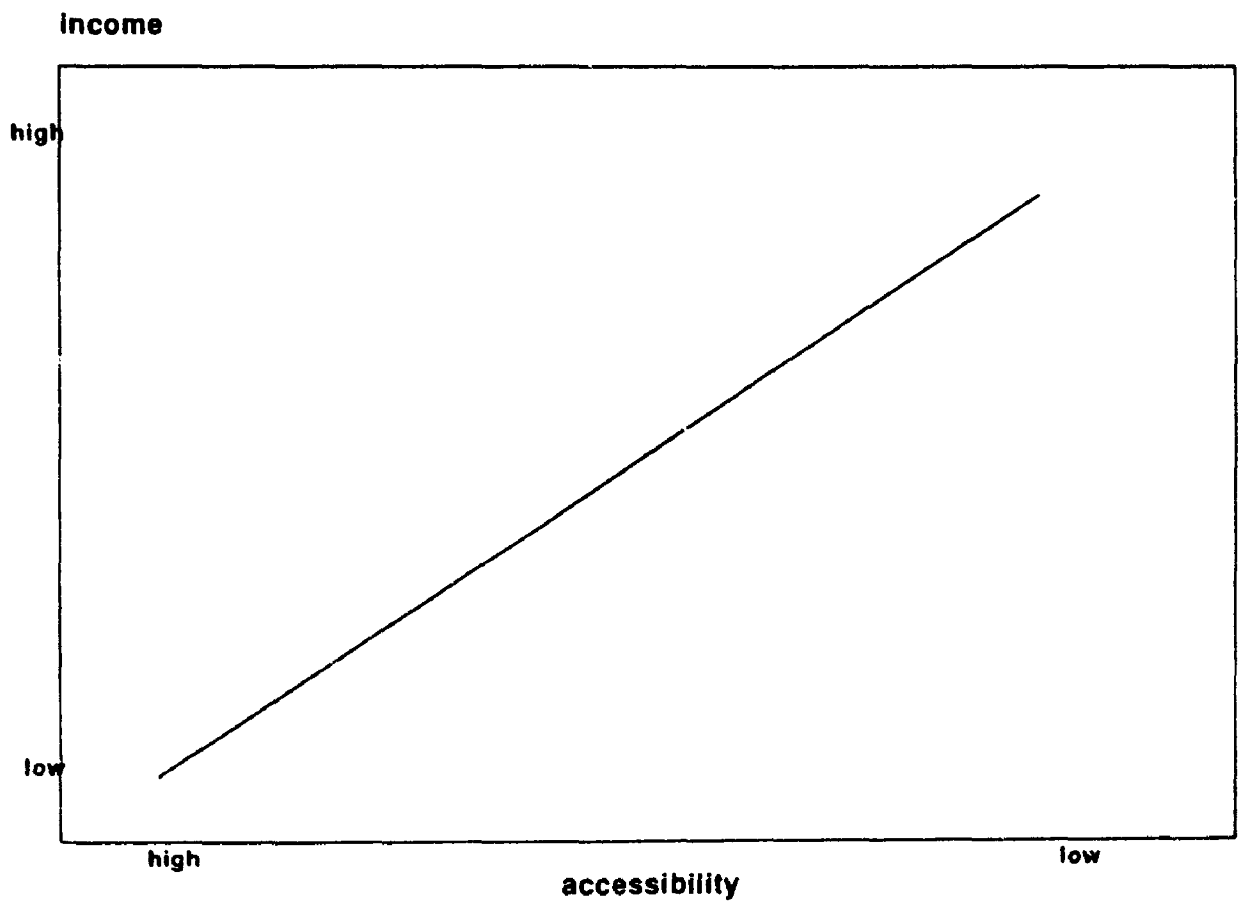


Figure 6.5: The Relationships Between Income and Accessibility

Figure 6.5b

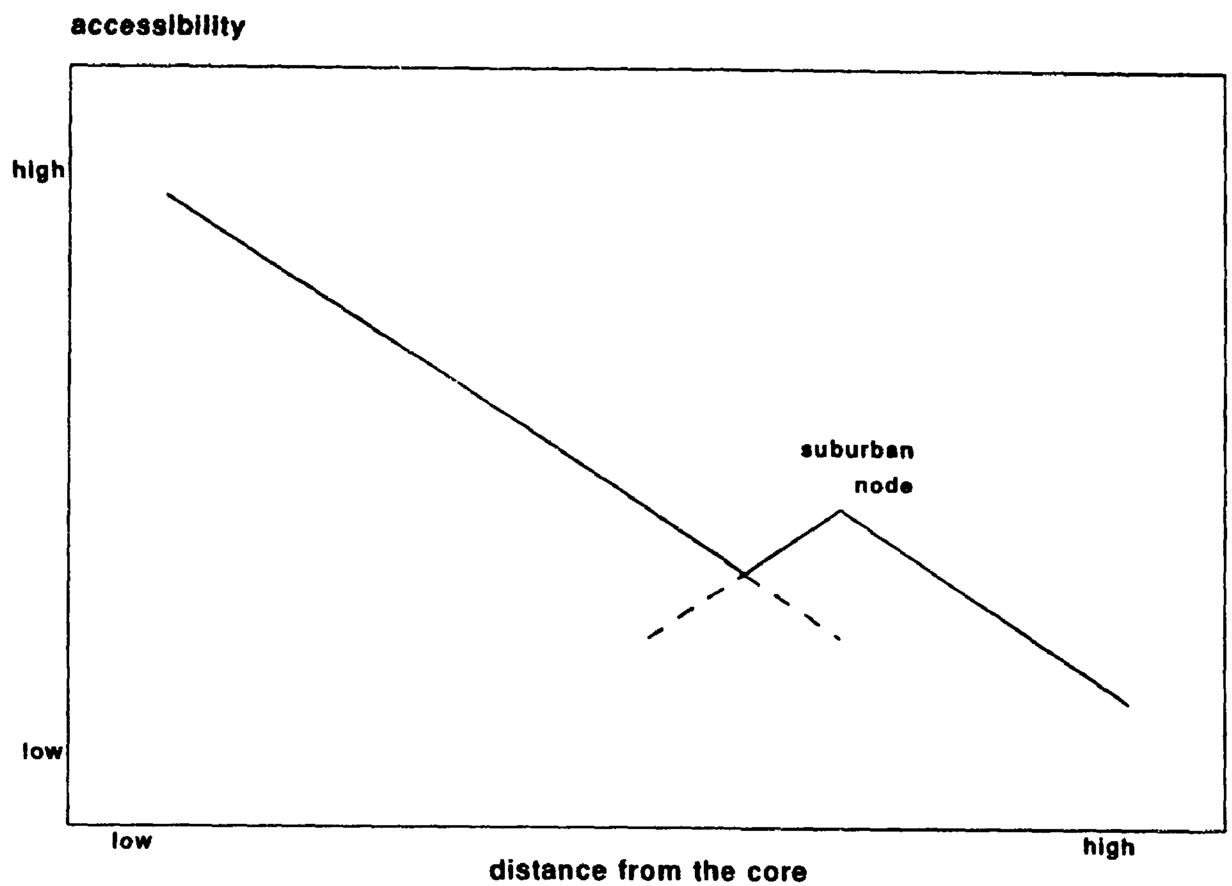


Figure 6.5: The Relationships Between Income and Accessibility

Figure 6.5c

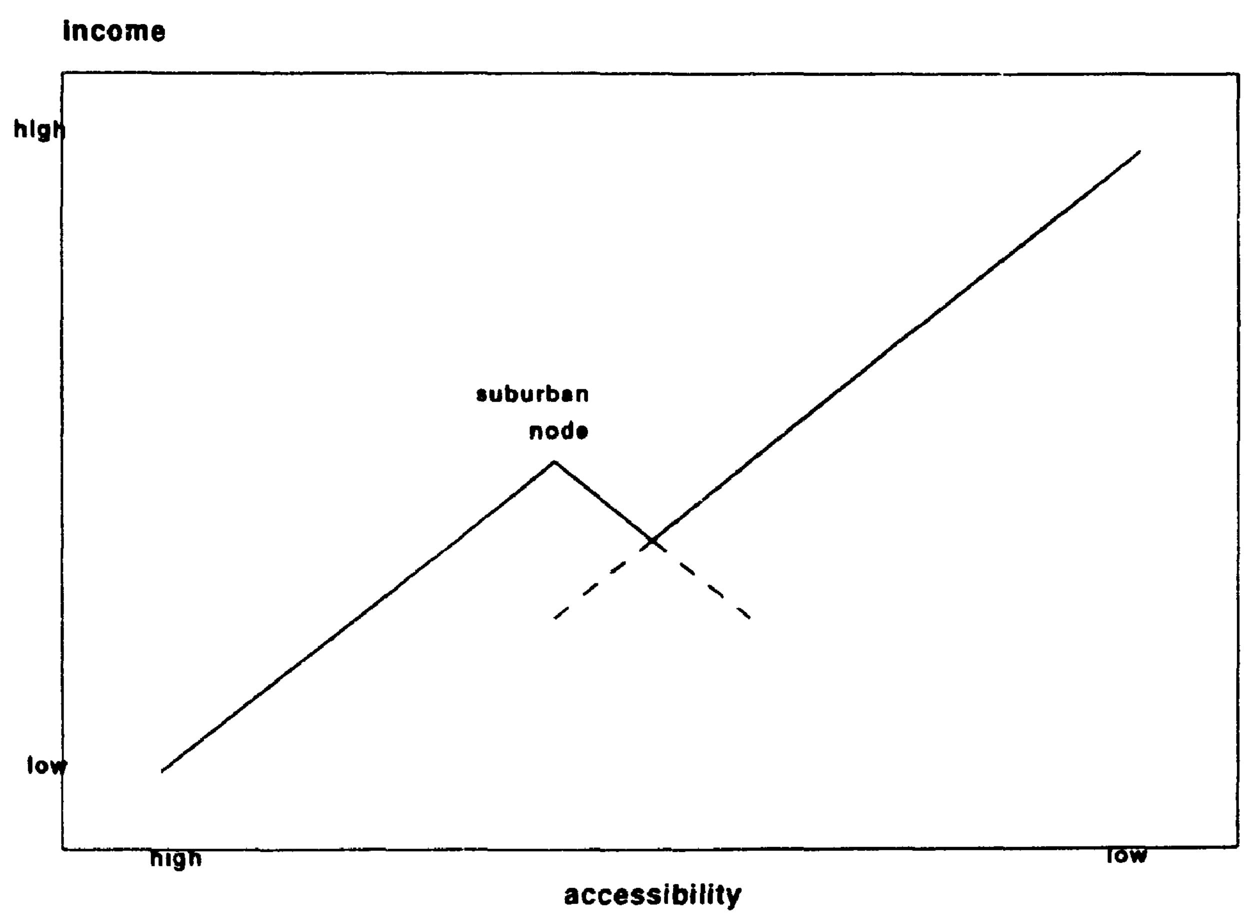
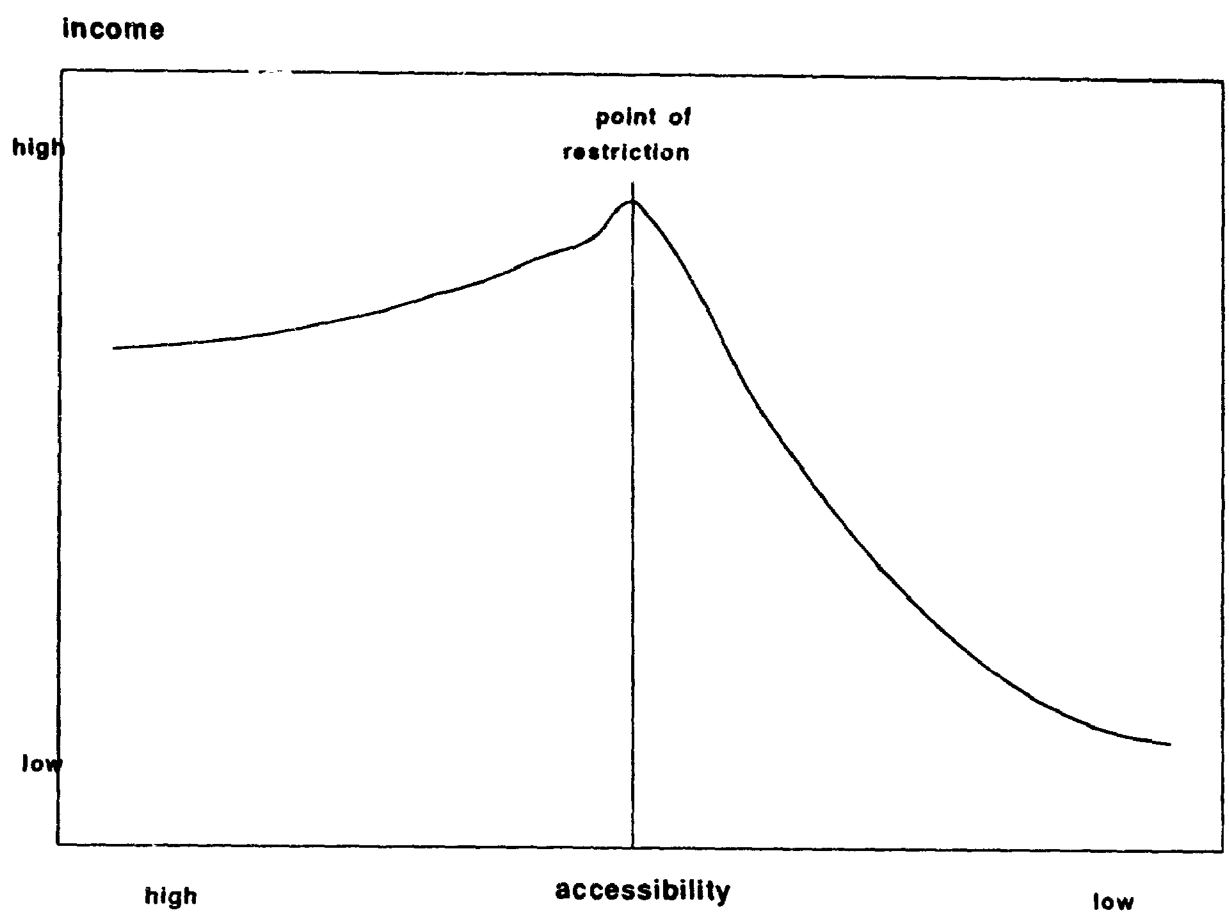


Figure 6.6: The Effect of Land Constraints on Income Distribution



CHAPTER 7:

EMPIRICAL ANALYSIS I: DESCRIPTIONS OF TRENDS

7.1 Introduction

Trends in the spatial and temporal patterns in dwelling value in Metropolitan Toronto are described below. These help assess whether the recent centripetal shifts in income status are simply "more of the past", or constitute an emerging change in urban form. To achieve this end, relative dwelling value distribution is examined for 1961, 1971, 1981, and 1986. Following, the relative percent changes in these distributions are discussed for different time frames. These data are from the Census of Canada (1961-1986), collected at the census tract level.

Within the patterns and trends identified, a discrete sectoral arrangement in dwelling value repeats over time. These sectors provide the basis for additional testing of the model, discussed in Chapter Eight.

Variations in the patterns of accessibility are outlined in this section. Specifically, the spatial differences between employment potential and distance from the core are highlighted.

The last component of this chapter is the pattern of dwelling values for 1986, collected at the enumeration area level. These units correspond to the specific blocks used in the testing of the model. This pattern is compared to the census tract-based arrangement to help justify the applicability of those trends to the enumeration area/block results. Further, the block-based spatial arrangement provides the cornerstone for the comparison of the distribution of actual dwelling values with those of the model's predicted values, presented in Chapter Nine.

7.2 Relative Dwelling Value Distribution

Estimated dwelling market values for the periods of 1961, 1971, 1981 and 1986, based on census tract statistics, are presented in Figures 7.1 to 7.4. These provide insight into a number of spatial and temporal trends[1]. Overall, the figures depict (i) the existence and maintenance of the above average dwelling value spatial sectors, (ii) the discrete locales of highest value dwellings within them, and (iii) an historical progression of above average value homes toward the periphery.

In each map there is a general spatial dominance by moderate to lower relative values of dwellings. This is expected as these represent the middle range of housing values and the bulk of the market. There are three discrete locales

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[1] It should be noted that the inner city BPU located along the waterfront is not included in the maps involving 1961 data or in the map of the sectors. This land area was reclaimed from the bay during the 1960s. Some of the new waterfront within the City of Toronto is almost a kilometre south of the original shoreline (Spelt, 1973).

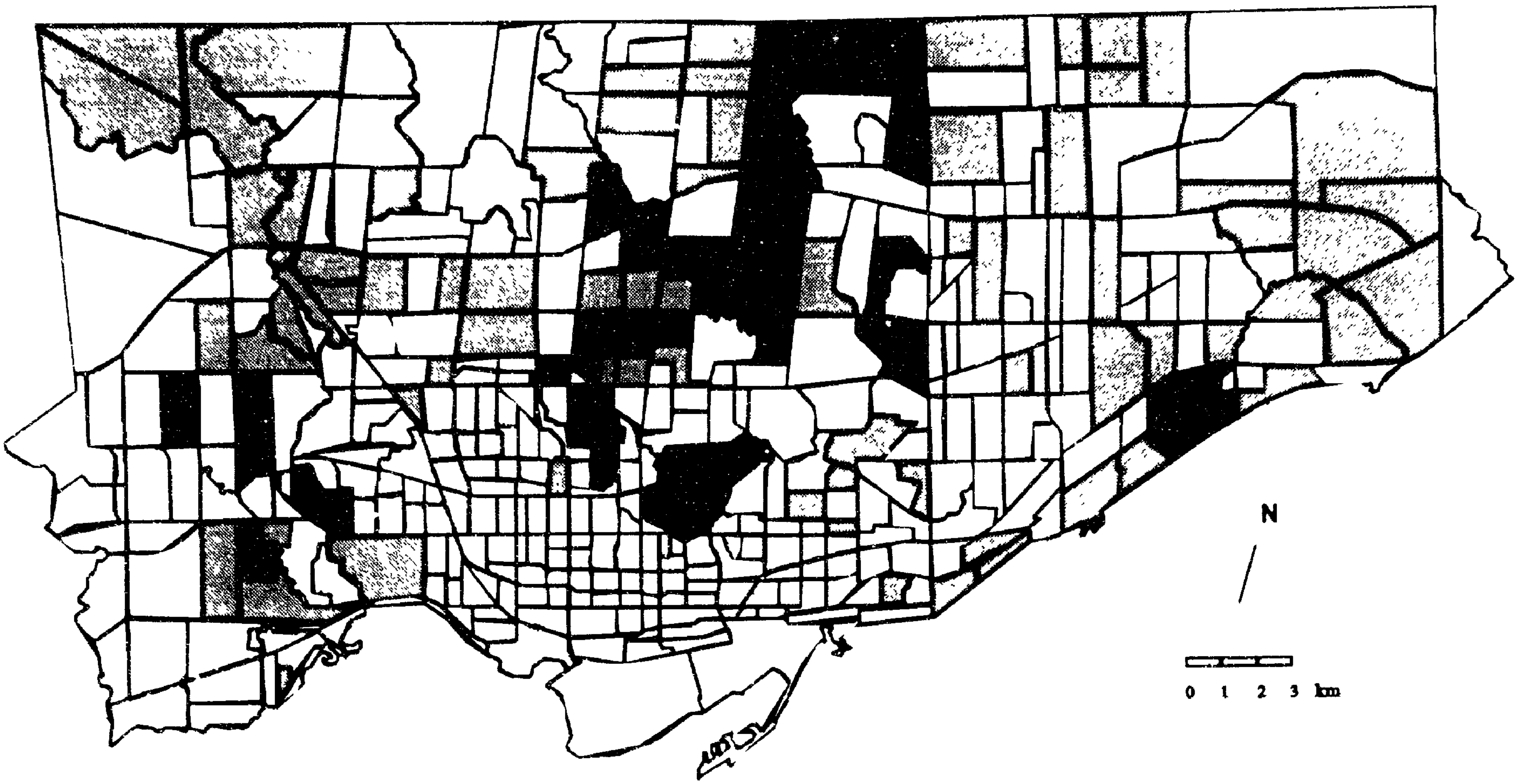

Figure 7.1: 1961 Dwelling Value

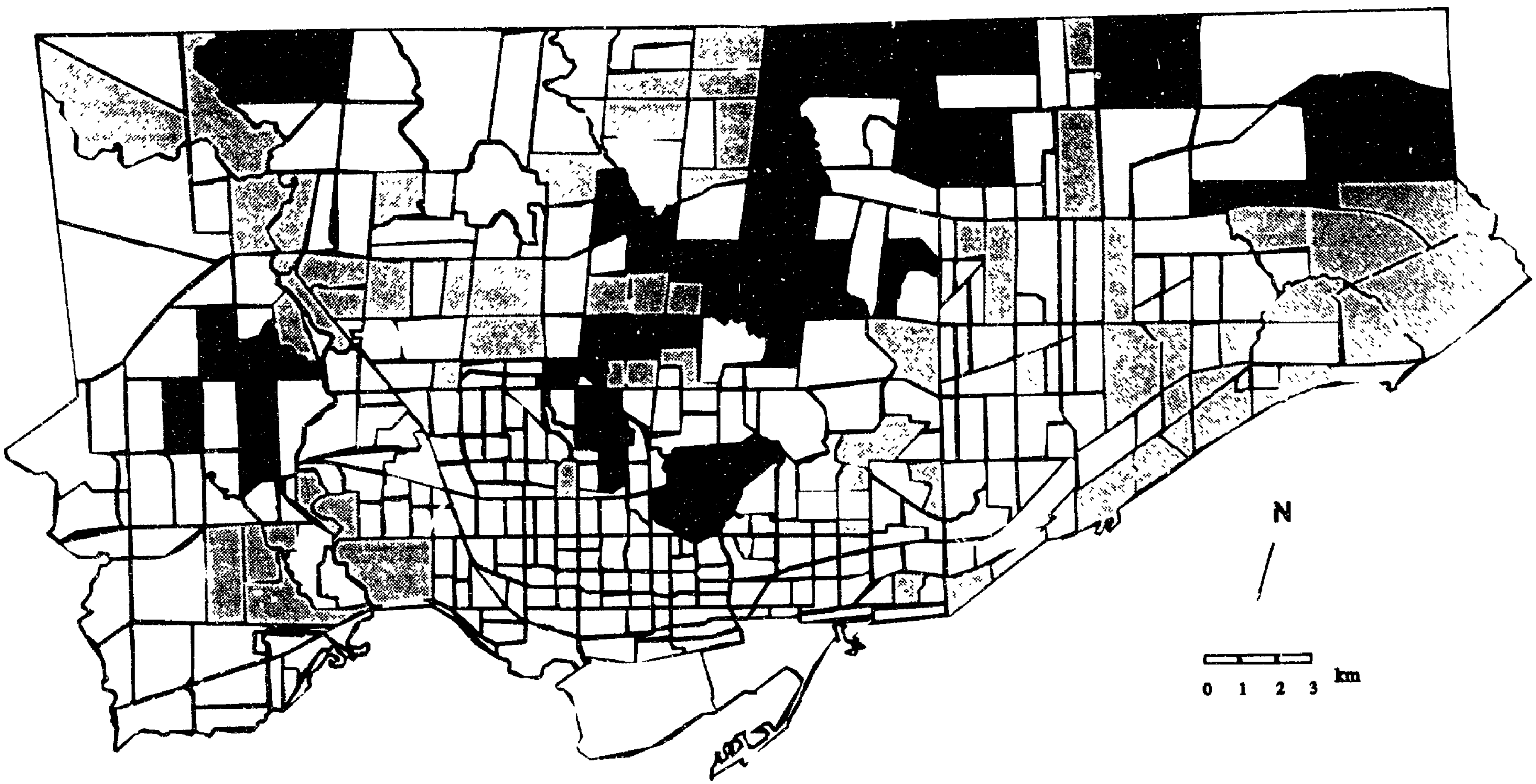

Figure 7.2: 1971 Dwelling Value

> +2 s.d.

> +1 s.d. to +2 s.d.

> average to +1 s.d.

average to -1 s.d.

< -1 s.d.

containing the highest relative values. The census tracts in these districts may fluctuate between the highest and second highest categories over the time frame, but each of the three areas maintains some components of highest relative value in each map. The above average categories are located in a few "higher value sectors" radiating from the CBD, for the most part. This is especially true for the highest and second highest levels of relative value.

Over time, the above average value units shift from (i) the 1961 pattern of being concentrated within the "higher value sectors" and dispersed through part of the "middle" region of the study area (as compared to near the CBD or near the periphery), to (ii) the 1971 configuration of being concentrated within the same sectors but dispersed through part of the "peripheral" region, and later to (iii) being increasingly concentrated within the "higher value sectors" only, such as in 1981 and 1986. Within the "higher value sectors" but not including the three discrete locales, there is a shift in the relative value from 1961 to 1986 of (i) some of the "peripheral" region units from the second highest level to a below average level, and of (ii) some of the "middle" region units from below average to above average.

Further, there is a continued outward movement of above average value units. This occurs first within the higher value sectors for the most part, and is followed later by a

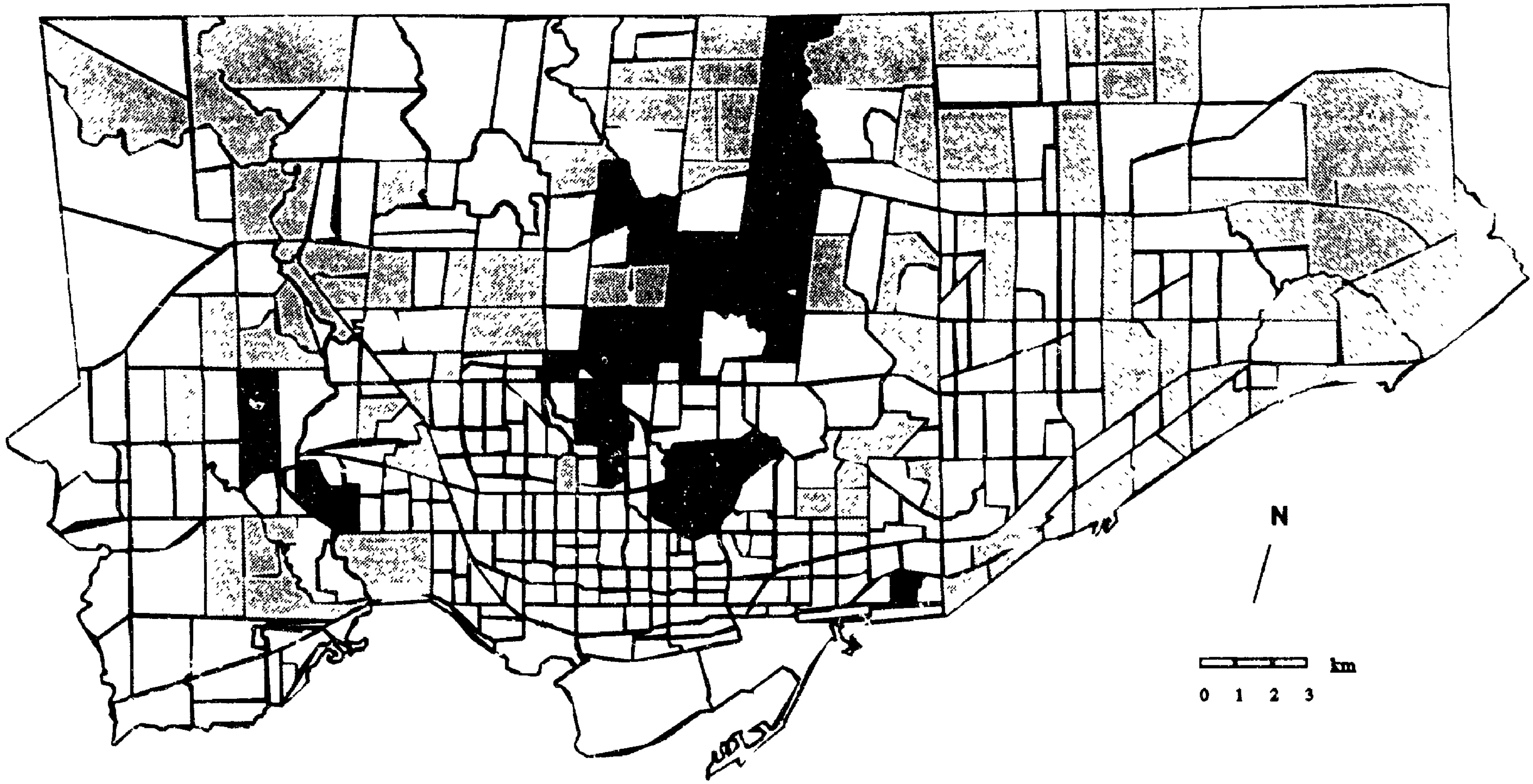

Figure 7.3: 1981 Dwelling Value

> +2 s.d. | > +1 s.d. to +2 s.d. | > average to +1 s.d. | average to -1 s.d. | < -1 s.d.

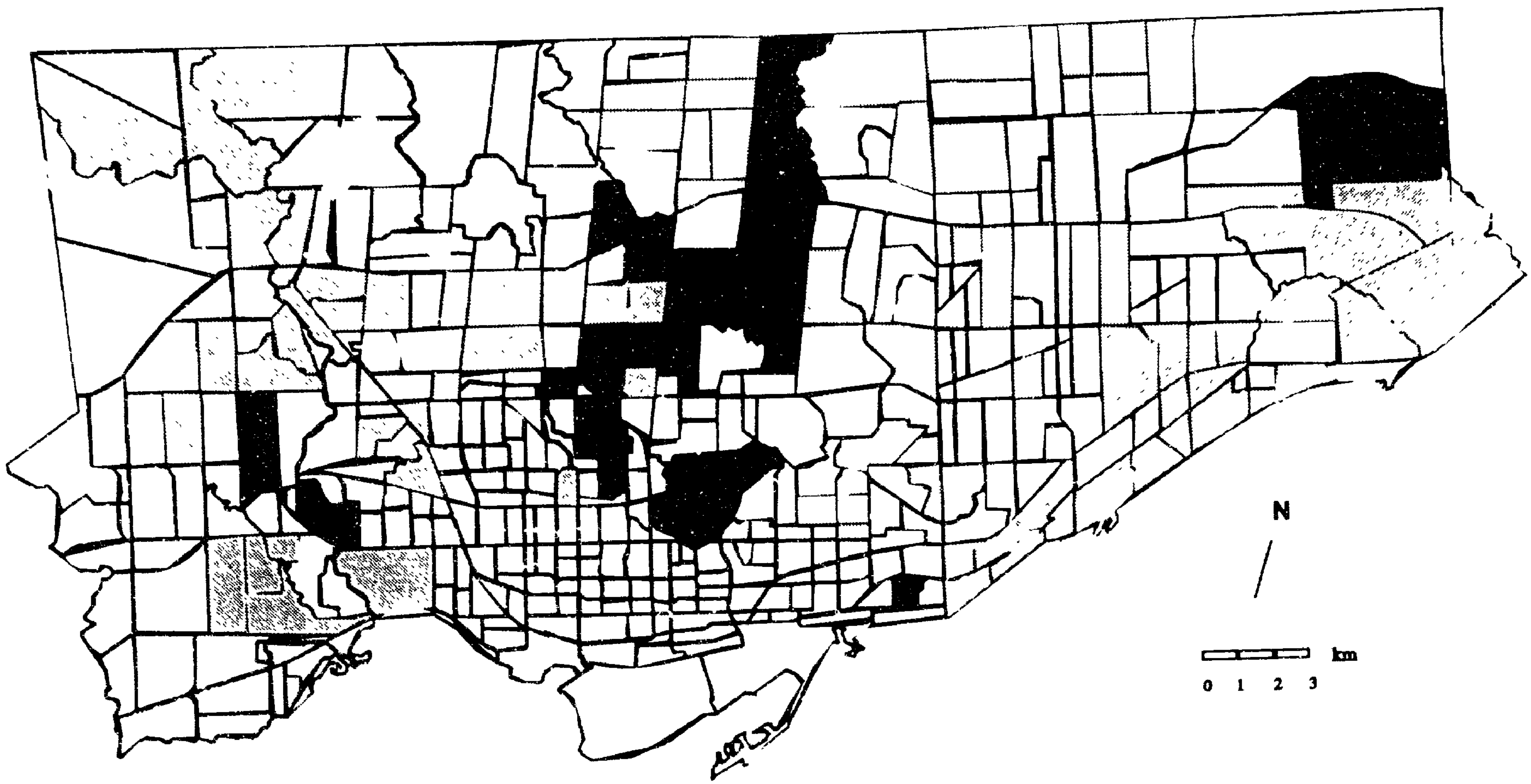

Figure 7.4: 1986 Dwelling Value

> +2 s.d. | > +1 s.d. to +2 s.d. | > average to +1 s.d. | average to -1 s.d. | < -1 s.d.

similar centrifugal shift in other parts of the study region. This trend is particularly evident in the 1961 and 1971 maps. By its absence in the 1981 map, it may be postulated that the general trend continued, but now existed beyond the study area. This concurs with the traditional explanations of the peripheral extension of the urban form and land rent modelling.

Following this temporal outward shift, there is a subtle decline in value for the most part (1981 and on), excluding the three discrete locales. This is more noticeable (i) in the "peripheral" region, and (ii) in scattered areas not within the upper value sectors. Again this is in accordance with the bulk of the classical urban literature, suggesting that the higher income households will continue to reside at or near the periphery (Alonso, 1964; Hoyt, 1939). However, there is also an increase in value (i.e. an upward revaluation) in the "middle" region, especially near some of the established high value locales. Most of this rise involves "lowest-to-lower" and "below average-to-above average" shifts in dwelling value. Still, the revaluations are contrary to the established explanations.

7.3 Relative Percent Change in Dwelling Value Distribution

It is important to note at the outset that a high relative percent change in dwelling value does not necessarily correlate with high dwelling value. It is indicative of an area that is undergoing a greater revaluation than the rest of the study region. In other words, over a certain time period that specific area is relatively more valuable per unit of price than other areas. Examination of the relative amount of percent change can provide insight into the spatial pattern of revaluation, regardless of the actual dwelling value. Further, extending this analysis over certain periods of time, can help explain temporal patterns of revaluation. This information is contained in Figures 7.5 to 7.7.

It is evident from Figure 7.5 that the areas of above average percent change in dwelling value for the period of 1961 to 1971 are distributed through the "middle" to "peripheral" region, for the most part. Areas containing the two highest categories of percent change are found mostly at the periphery of the study territory. In contrast, the "inner" to "middle" region is predominantly below average. There is little indication of the three locales identified earlier, or of the sectoral pattern other than from the "middle" to the "periphery". This is not dominant; instead, it conforms with the overall pattern.

The 1971-1981 distribution of percent change (Figure 7.6) is dramatically different. The "middle" to "peripheral" region tends to be below average in relative change except for in the "higher value sectors". The "inner" to "middle" area contains higher categories than in the previous time period,

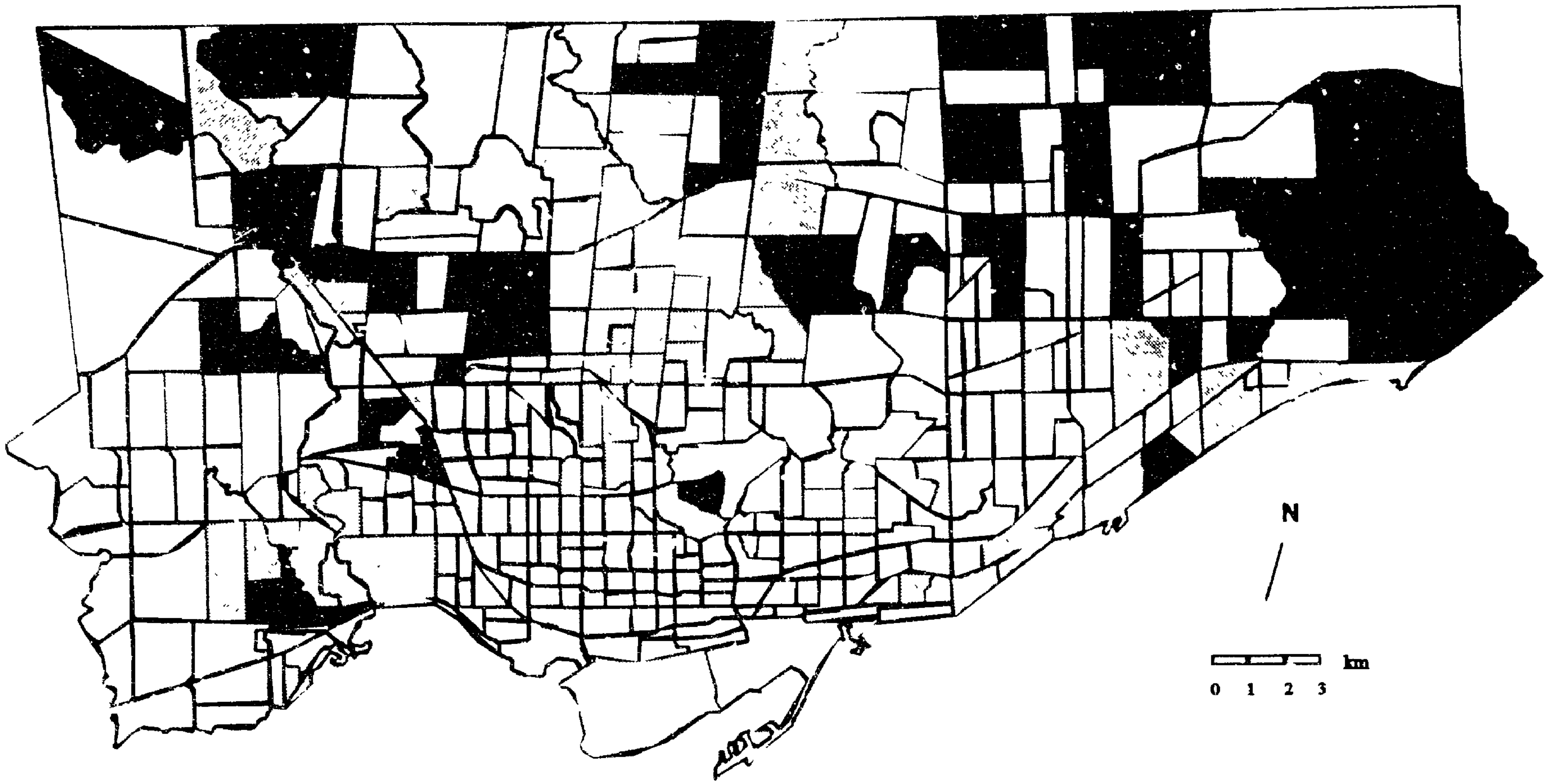

Figure 7.5: 1961-1971 Percent Change in Dwelling Value

> +2 s.d.   > +1 s.d to +2 s.d.   > average to +1 s.d.   average to -1 s.d.   < -1 s.d.

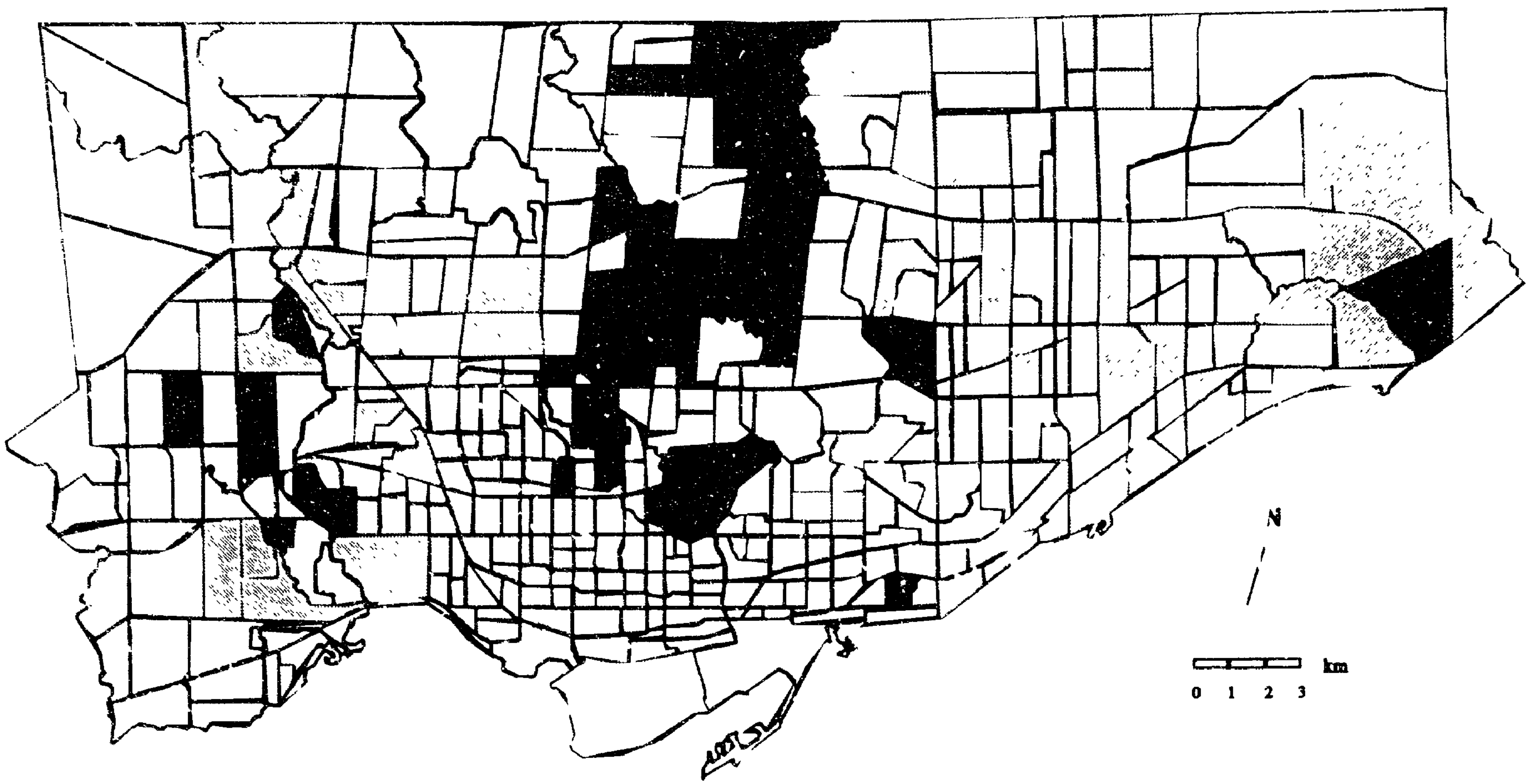

Figure 7.6: 1971-1981 Percent Change in Dwelling Value

> +2 s.d.

> +1 s.d. to +2 s.d.

> average to +1 s.d.

average to -1 s.d.

< -1 s.d.

for the most part. This alteration in pattern is due to the "higher value sectors" (described previously) now containing the highest concentrations of above average percent change.

The 1981-1986 map (Figure 7.7) differs from both of the earlier maps. The two highest categories of relative percent change are spread through the "middle" to "peripheral" region, with a few exceptions. However, this pattern holds true for the lowest relative change group as well. The "average to plus/minus one standard deviation" divisions (i.e. closest to average) are found throughout. There is a weak indication of a sectoral pattern.

These distributions of relative percent change in dwelling value create patterns that are different from those shown in the previous set of maps. However, the probable explanations are related. The distribution of greater relative percent change units (1961-1971) in Figure 7.5 is concentrated in the outer half of the study territory. This is similar to the changes in the patterns of actual values between the 1961 and 1971 maps (Figures 7.1 and 7.2), and reflects the suburban development occurring at that time[2].

The spatial arrangement evident in the 1971-1981 map is the

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[2] For discussion concerning the timing, quantity and location of suburban development in Metropolitan Toronto, see Kerr and Spelt (1965), Murdie (1969), Spelt (1973), and Baine and McMurray (1984).

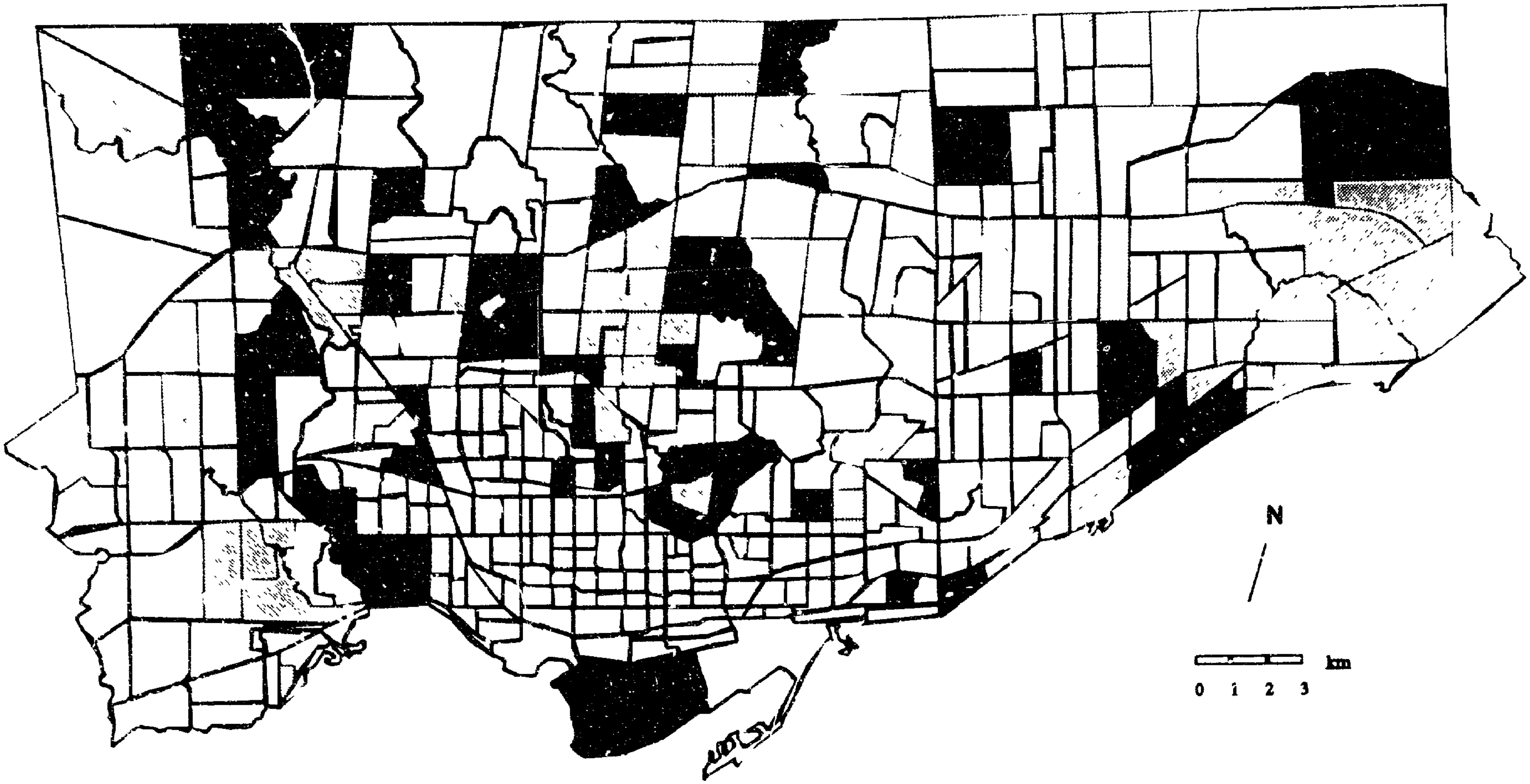


Figure 7.7: 1981-1986 Percent Change in Dwelling Value

> +2 s.d. | > +1 s.d. to +2 s.d. | > average to +1 s.d. | average to -1 s.d. | < -1 s.d.

result of a turbulent decade with respect to the housing market and the overall economy - in the intensely contained greater Toronto region, rapid price escalation and limited growth in supply led to substantial revaluation of new and existing stock[3]. The pattern of relative percent change over this time period reinforces the dwelling value domination evident in the "higher value sectors".

Figure 7.7, depicting the period of 1981 to 1986, holds a mixture of patterns with resp ct to percent change. Generally, the higher relative value increases are found within the "higher value sectors", but not in those census tracts that experienced this upper level increase in the previous time period. Further, additional areas of higher percent change are dispersed through study territory. The same is generally true for the "average to plus one standard deviation" category. This group shows a slightly greater concentration within the "middle" region. The limited number of cases of the lowest relative percent increase tend to be at or near the periphery. The presence of one census tract in the northeast corner exhibiting the highest category is likely because this general area contains the only significant amount of vacant land within Metropolitan Toronto. New development in this tract during the 1981-1986

[3] There are numerous examinations of the speculative price bubble of the 1970s. See, for example, Scheffman (1978), Greenspan (1978), and Frankena and Scheffman (1980).

period could explain the high average value increase. Overall, the pattern in Metropolitan Toronto correlates with the suggestion of a revaluation occurring within the study region, especially in the "inner" to "middle" region.

One problem with restricted time frames is the distortion that may occur due to short term market fluctuations, the temporary influence of submarkets, etc. To avoid this potential pitfall, percent change in dwelling value should also be examined for the full time period.

However, there are limitations to comparing the 1961 scenario to that of 1986. First, there is some disagreement between the 1986 census tract boundaries and those for the 1961 structure. Second, in the early 1960s there was still significant pockets of vacant or agricultural land within Metropolitan Toronto (Kerr and Spelt, 1965; Murdie, 1969; Metropolitan Toronto Planning Department, 1987a). This may distort the average dwelling values in the peripheral census tracts (due to the presence of agriculture, etc.) compared to the continuously built up remainder of Metropolitan Toronto.

The use of 1971 as the base year overcomes these obstacles. First, it has greater similarity with the 1986 census tract boundaries. Second, the problem of open space or agriculture is reduced. By 1978, Metropolitan Toronto was principally built up with regard to available space suitable for subdivision development - thus, the peripheral development from the start of the decade was typically suburban and not rural. This permits comparisons of average dwelling value and its percent change within Metropolitan Toronto, as the dominant land use category in the census tracts is urban. Further, from the early 1970s and extending through to recent years, development in Toronto (and the surrounding area) has been subjected to planning constraints (Code, 1975; Frankena and Scheffman, 1980, Metropolitan Toronto Planning Department, 1989). This contributes to a greater homogeneity (with the regard to the influence of planning) within the 1971-1986 period than within 1961-1986.

The 1971-1986 pattern is shown in Figure 7.8. All but one of the census tracts contained in the two highest categories of above average percent change fall within the "higher value sectors" identified earlier. Outside of these "sectors", two related patterns emerge: (i) the presence of above average percent change within the "inner" to "middle" region, and (ii) the concentration of the areas of lowest percent change at or toward the periphery. This supports two points made previously. First, the patterns of change correlate with the existence of sectors. Second, the levels of revaluation do not correspond to peripheral growth, with value declining toward the center. Thus, this is contrary to much of the urban literature.

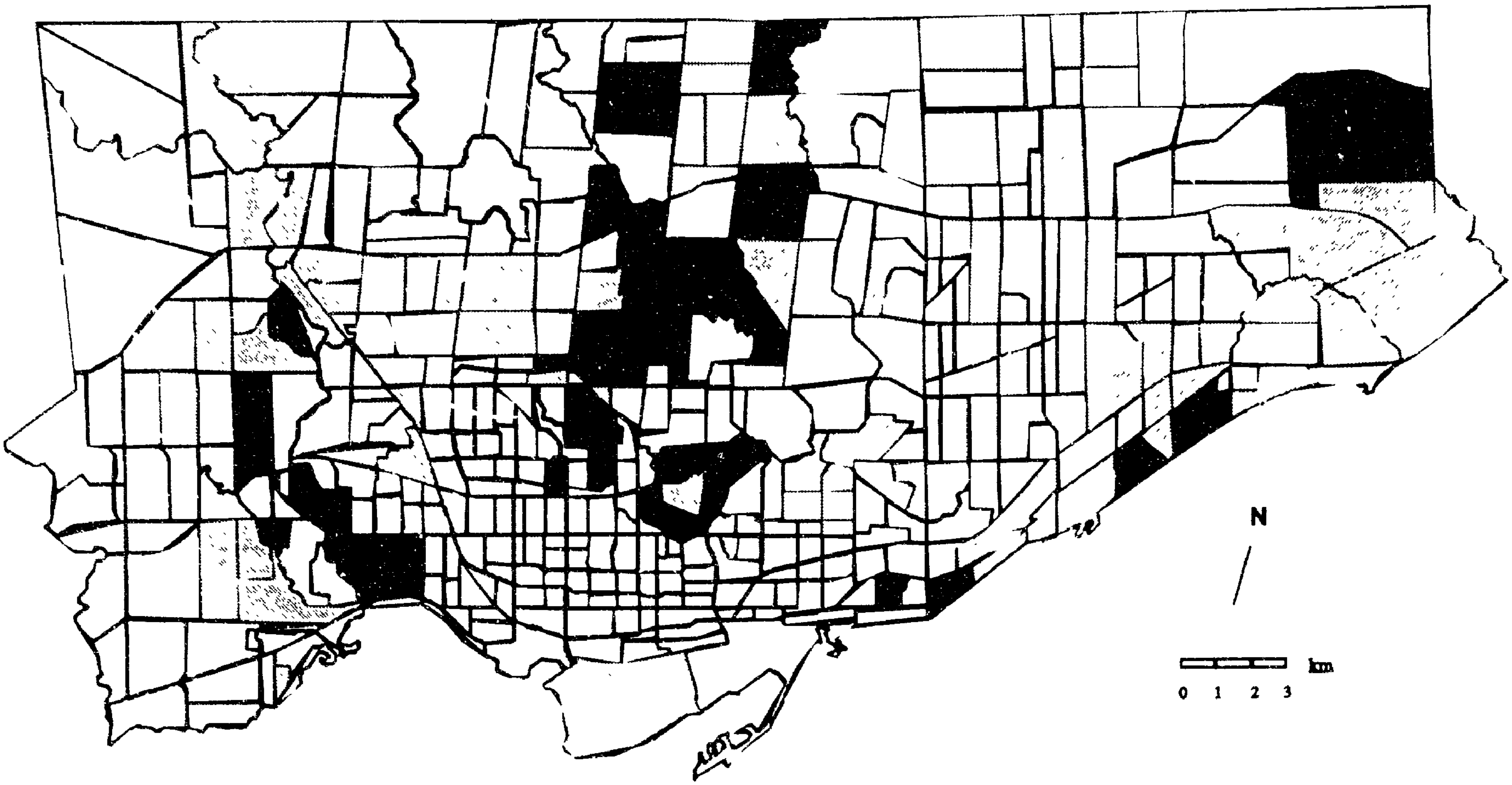


Figure 7.8: 1971-1986 Percent Change in Dwelling Value

> +2 s.d. | > +1 s.d. to +2 s.d. | > average to +1 s.d. | average to -1 s.d. | < -1 s.d.

7.4 Identification of Sectors

There is a repeating pattern in the maps of actual dwelling value. The higher value areas tend to be located in a sectoral arrangement, extending from near the core toward the periphery. Early growth (i.e. 1961 for this research time frame) suggests the outward extension of these sectors to be the primary locations of the relatively higher value dwellings being added to the built up area.

This is supported by Murdie (1969) in his 1951-1961 factorial ecology of Metropolitan Toronto. Murdie arbitrarily assigns sectors to Metropolitan Toronto in a geometric fashion to test for their existence (Figure 7.9). He notes that the abstract sectors used in his analysis may bisect or clump together areas of high and low economic status. He further recognizes this to be the case in sector 1, for example.

> Nevertheless, the results from the variance analysis appear to be conclusive and it can be stated with very little doubt that economic status (1951) is distributed primarily by sector in Metropolitan Toronto. (Murdie, 1969: 159)

He later points out that the 1961 analysis confirms this sectoral distribution, to an even greater extent.

This raises two points. First, the existence of sectors of economic status is most likely. Second, the delimitation of these sectors prior to exploration of economic status can be misleading.

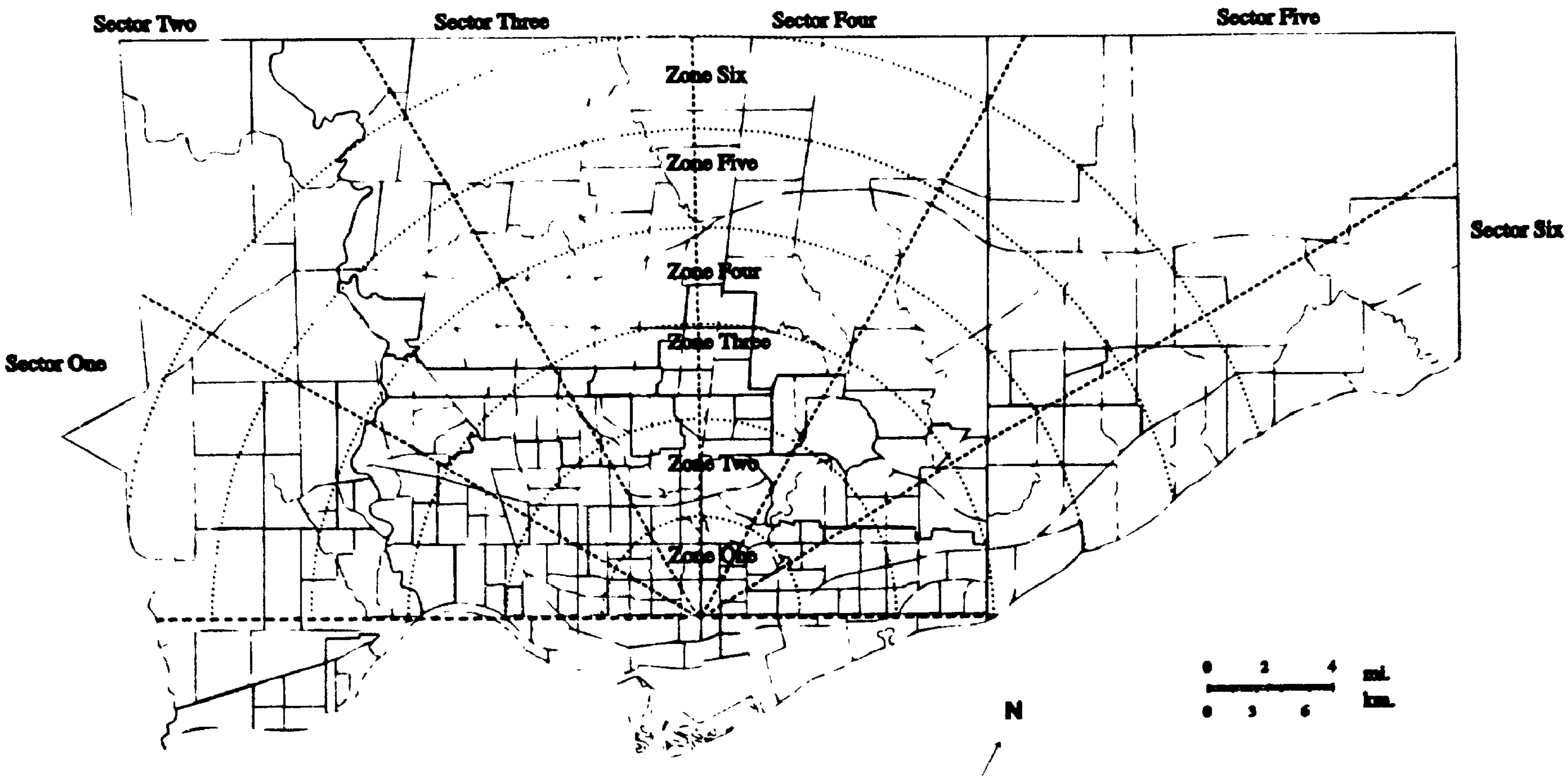


Figure 7.9: Sectors and Zones, 1961

Source: Murdie, 1969

Based on the dwelling value distributions shown in Figures 7.1 to 7.4, six sectors can be delimited. These are evident over the full time period, and not simply a temporary arrangement. Further, their presence prior to 1961 is supported by Murdie's analysis (although not the delimitation presented here). The six are not equal in size (as per Murdie's abstract dissection of Toronto), but they do consider the definitive existence of sectors of economic status on the landscape, and thus provide a closer approximation of reality. The resultant sectoral pattern is shown in Figure 7.10. This provides the basis for spatially "dissecting" the study area to permit additional testing of the model's representativeness.

7.5 Patterns of Accessibility

In this dissertation, the accessibility variable is measured in two ways: (i) distance from the core, and (ii) an employment potential calculation. The resulting spatial distributions are shown in Figures 7.11 and 7.12, respectively.

Traditionally, and in some of the newer models, accessibility is dealt with in the simplistic manner of gauging the linear distance from the core to the location in question. Thus, locales that are situated at relatively the same distance, should contain the same level of access. The map of linear distances for Metropolitan Toronto (Figure 7.11) consists of

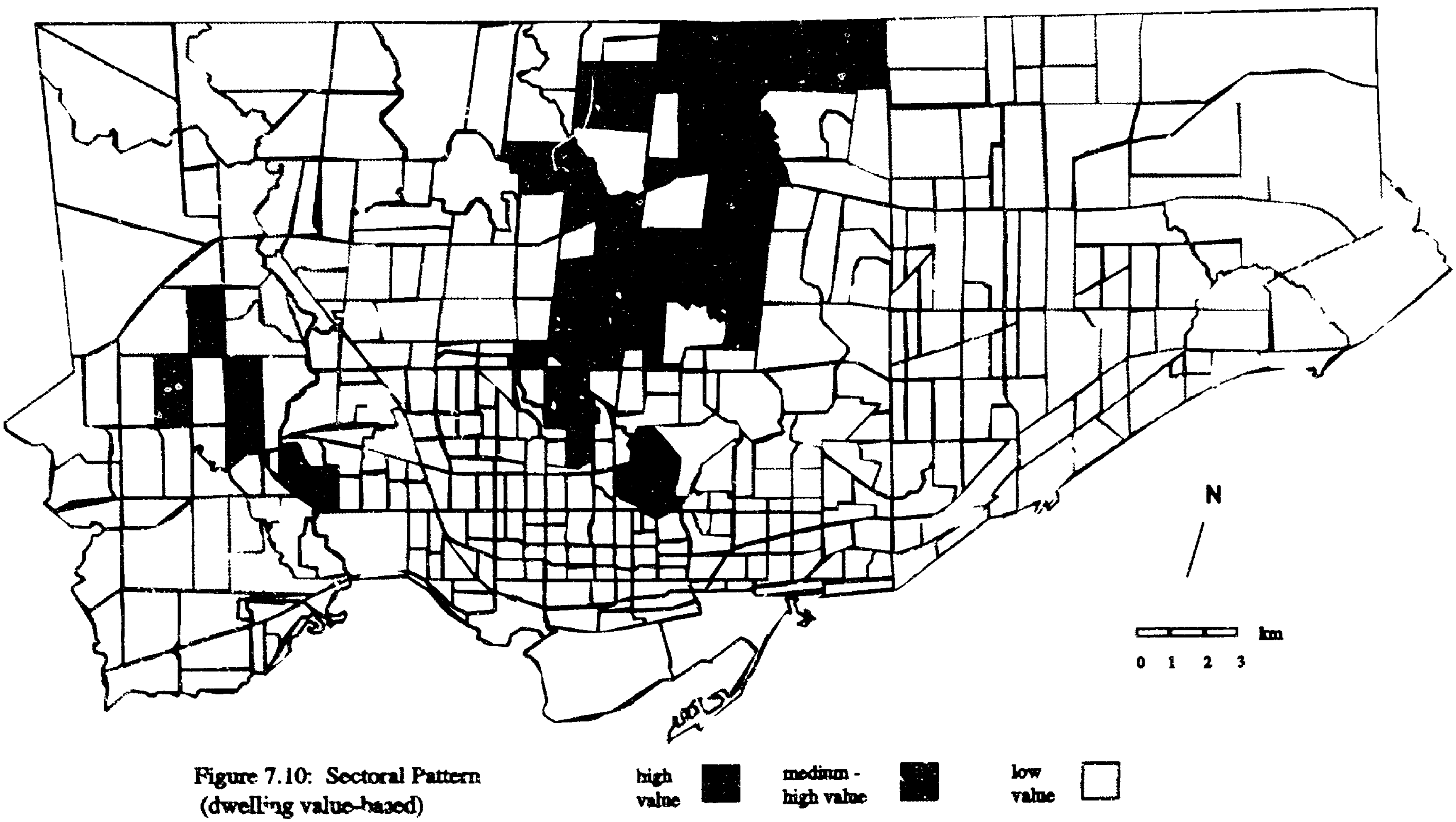


Figure 7.10: Sectoral Pattern
(dwelling value-based)

concentric rings emanating from the core. Each ring extends approximately 4.5 kilometres farther out; the resultant pattern contains six areas covering the total study area. The use of six bands corresponds to the number of categories depicting the employment potential pattern. The bulk of Metropolitan Toronto lies within the first four rings. The areas of exception are the extreme northwest (contained in the fifth band), and the larger area to the northeast. The latter zone contains over half of Scarborough, and falls in the fifth and sixth rings. This section is the farthest from the core.

The relative employment potential calculations, performed for each BPU, show a different composite pattern (Figure 7.12). The Basic Planning Units containing above average accessibility are concentrated in a band extending along the lakeshore from the western edge of Metropolitan Toronto to areas just east of the core. In comparison with the distance map, this stretches from the fourth ring in the west to the second ring in the east - an obvious skew.

In addition, there are a number of BPUs with above average values distributed through the "middle" region. These are scattered from the western edge of the study area to near the center of Scarborough. The tracts with the lowest employment potential values are found in the northeastern section of Scarborough (corresponding with the sixth ring), and

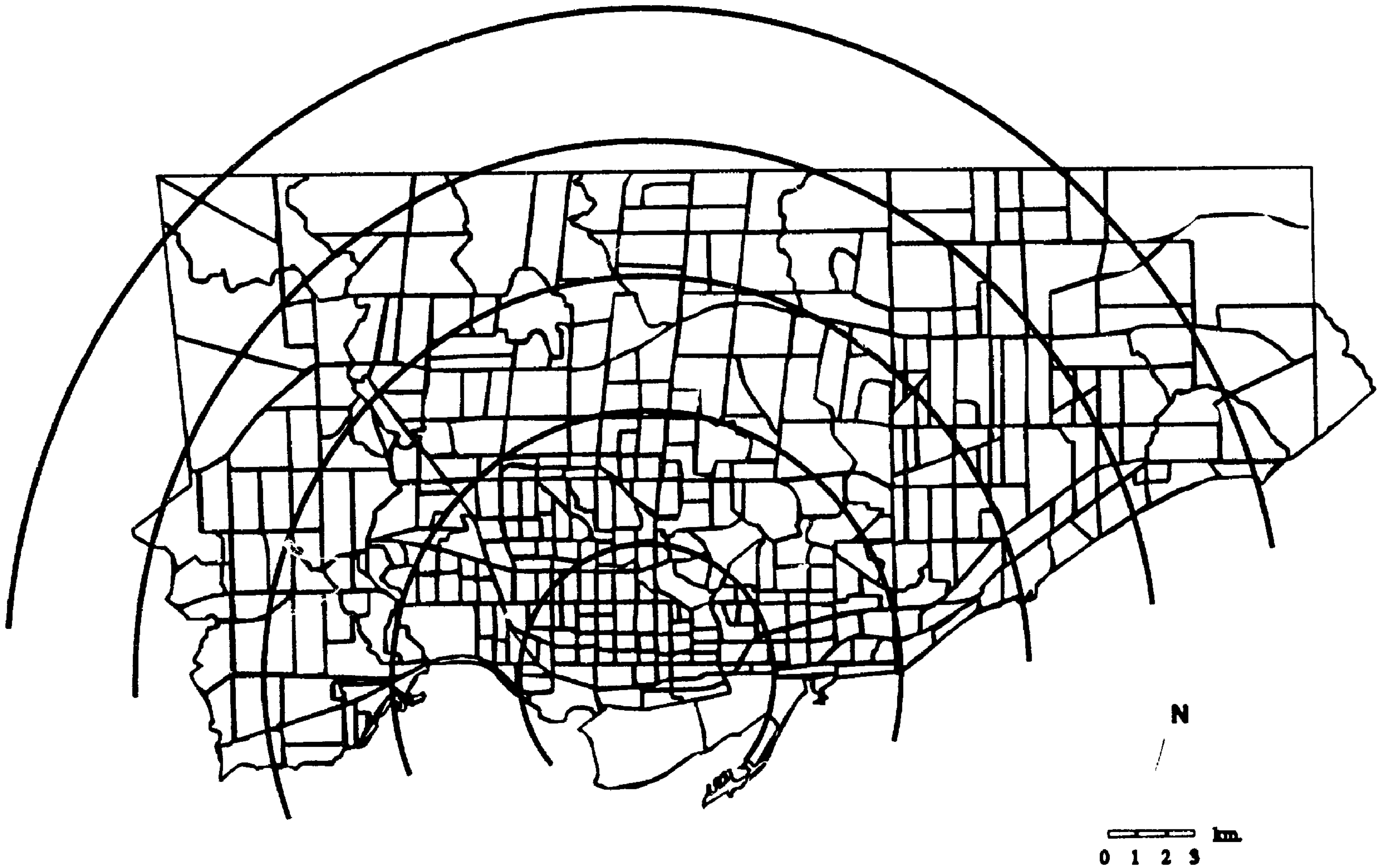


Figure 7.11: Linear Distance From The Core

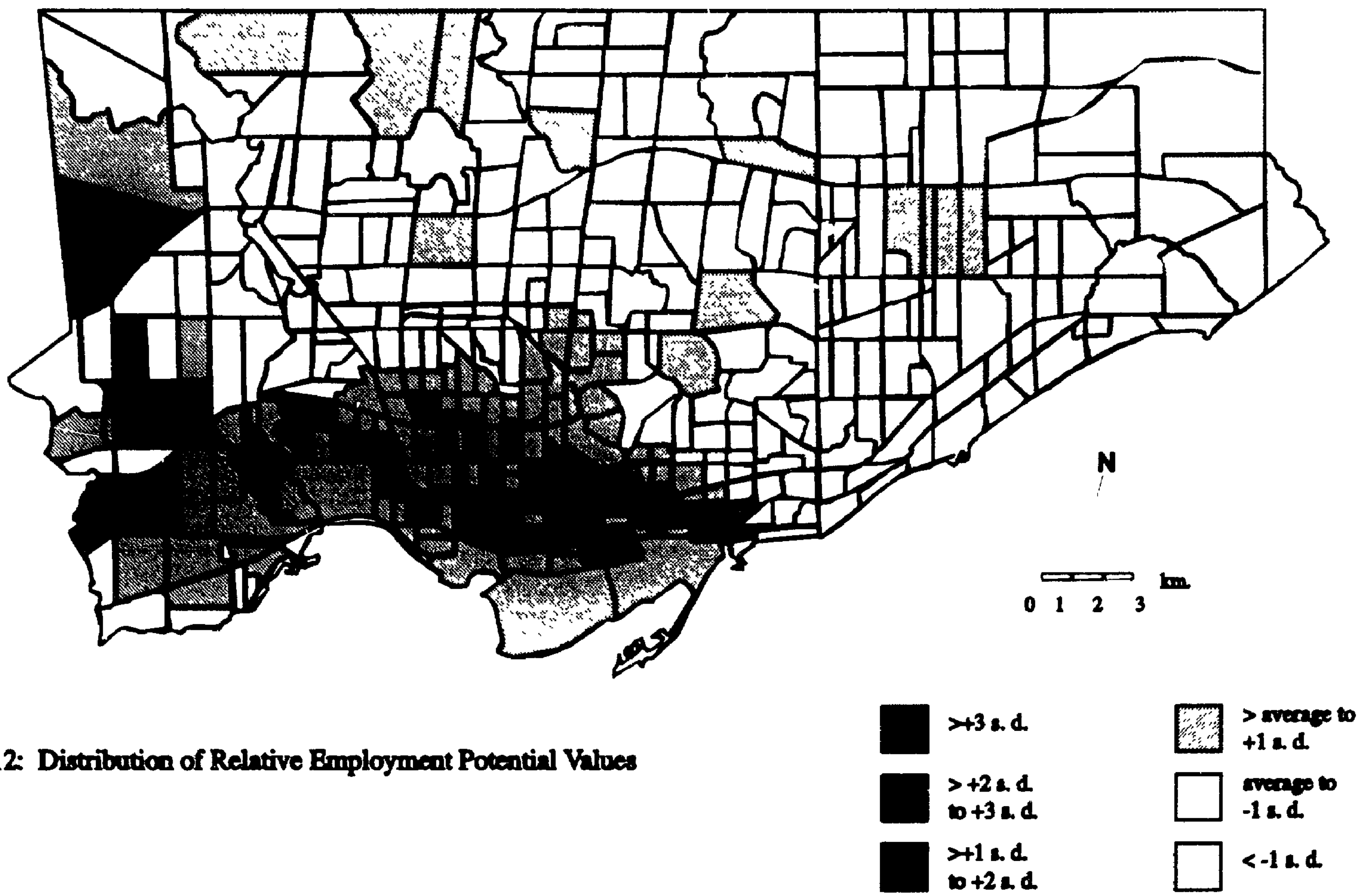


Figure 7.12: Distribution of Relative Employment Potential Values

extending along the eastern lakeshore. This low access "arm" does not concur with linear distance measures.

Variations within the elongated zone of above average values reinforce the "westward" trend. The two highest categories of relative employment potential are concentrated around the core (as expected) with an intermittent extension into Etobicoke. The third highest category generally surrounds these BPUs. Its pattern is somewhat funnel-shaped; a pointed convergence occurs east of the core, with the dispersal of appropriate Basic Planning Units widening toward the western boundary of Metropolitan Toronto.

These patterns raise a number of points. There are differences between the distributions based on linear distance and employment potential; this may permit an evaluation of the effectiveness of the two different calculations. Their different contributions (with regard to access values) may affect the comparative results of the model, and the strengths of the regressions. There is a sectoral pattern of increased access extending from the core toward the west-northwest, and one of poor access expanding toward the northeast. This may have an effect on the degree of revaluation and/or dwelling value. This distinctive pattern in employment potential may contribute to a greater insight gained from the sectoral analyses. Lastly, the above average potential BPUs located throughout the "middle" region may also relate to the levels of revaluation (and value) occurring in these older suburbs.

7.6 1986 Dwelling Value (enumeration area-based)

Based on the blocks used in the iterations of the model, the corresponding enumeration area data for 1986 dwelling value is presented in Figure 7.13. The values are displayed in a relative format, consistent with earlier discussion. This permits a more direct comparison with the maps and relative values generated by the model, due to the size of the enumeration area (versus the census tract). These results are discussed in Chapter Nine.

In addition, the enumeration area-based pattern of 1986 dwelling value is compared to that generated at the census tract level to assess the degree of similarity. The patterns of 1986 dwelling values, shown in Figure 7.13 (enumeration area-based) and Figure 7.4 (census tract-based) are almost a mirror images. This is expected considering the limited areal differences in spatial units. The minor deviations that exist likely reflect the mollifying effect of the greater averaging that occurs at the census tract level. The strong similarity enables the trends identified in the census tract level discussion to be extended to the analysis of the 1988 block level data. Specifically, it supports the notion of testing the model on the full study area and by sector; further, it confirms the presence of a pattern of revaluation

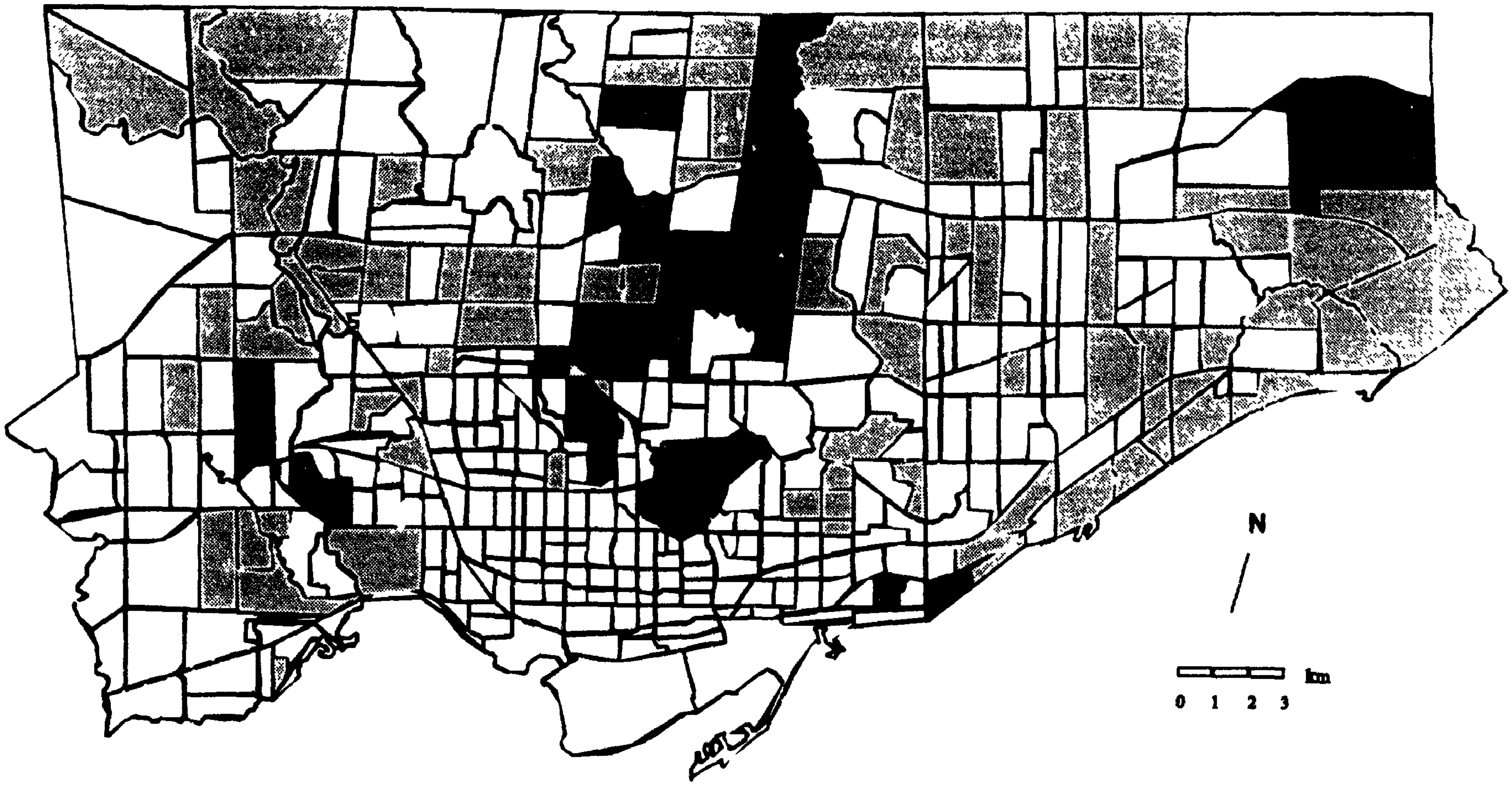
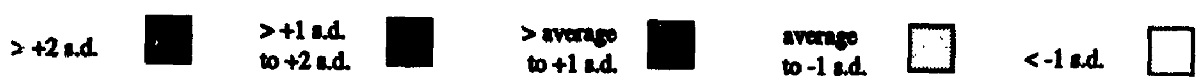


Figure 7.13: 1986 Dwelling Value (enumeration area-based)



that is in contrast to previous literature. These two aspects are examined in the following chapters.

CHAPTER 8

EMPIRICAL ANALYSIS II: APPLICATION OF REGRESSION TECHNIQUES

8.1 Introduction

The model delineates the relative locations of households within a metropolitan center, based on their predicted incomes. It allows for the existence of a polycentric urban form through the calculation of accessibility. Further, it incorporates budget limitations and potential suburban space consumption constraints into its equation-based structure.

In accordance with the previous explanations of the model's structure and the measurements of its variables, there are four components to be considered. These include: household income (which is measured in terms of dwelling value or private household income); a composite good (which is held proportionally constant); a residential space component (which is measured in terms of site area, floor area or a composite area of site and floor combined); and a transport or commuting component (this is calculated as an employment potential or as distance from the core). The latter component is related to the relative location and relative accessibility of the site.

8.2 Simple Linear Regression

Initially, simple linear regressions are performed on all possible pairings of variables[1]. These are executed to expose any strong relationship that may exist between two variables for the total study area. Table 8.1 lists all the variable combinations and their coefficients of determination (R^2).

TABLE 8.1: R^2 VALUES FOR VARIABLE COMBINATIONS

Variable 1	Variable 2	R^2
employment potential	dwelling value	.031
employment potential	household income	.002
employment potential	floor area	.001
employment potential	site area	.011
employment potential	composite area	.002
employment potential	distance from core	.382
distance from core	dwelling value	.117
distance from core	household income	.061
distance from core	floor area	.015
distance from core	site area	.000
distance from core	composite area	.005
dwelling value	household income	.640
dwelling value	floor area	.316
dwelling value	site area	.317
dwelling value	composite area	.436
household income	floor area	.236
household income	site area	.229
household income	composite area	.320
floor area	site area	.204

n = 117

Dwelling value and income provide the only relatively strong relationship. This is not surprising, as these measures are suggested to be partial subrogates. The limited strength of the relationship between distance and employment potential

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[1] It should be noted that the pairings of floor area:composite area and site area:composite area have been omitted. This is because both site and floor areas are used in the calibration of composite area.

suggests that while Toronto has an important core, it is not truly a monocentric city.

Moderately weak relationships exist between both dwelling value and income and the three quantity of space variables. While these are weaker than one might anticipate, it does imply that dwelling value is determined by more than just site and/or floor space. Theoretically, the relative location affects the per unit cost of space and the amount of commuting expense.

The same perception applies to the income variable and its relationships with the three quantity variables. Further, its lower R^2 values support the arguments of using dwelling value as a subrogate and of the inherent pitfalls involved in using income.

No real relationship exists between distance from the core and the amount of floor and/or site area. This is in contrast to the traditional literature on urban form and land rent. This result does reflect that a city does not grow equally at all locations along the periphery. It may also be the result of changing attitudes and planning directives toward types and densities of development over time. The effect of nodes of higher relative accessibility being dispersed throughout the urban area, and not simply downtown, may contribute to the distortion as well.

Based on the model and the theoretical analysis discussed earlier, increasing accessibility will result in increasing per unit cost of site space. No significant relationship is expected to exist with floor space, because per unit dwelling construction costs should remain the same throughout the city. Any change in this expense would likely be attributable to the nature of the site (difficulty in excavation, for example). Similarly, the relationship with the composite measure of floor and site space is anticipated to be weak due to the nature of its calculation. This is evident in the R^2 values which show no relationship exists between accessibility and floor/composite measures.

Per unit site costs, however, are expected to increase with greater accessibility. The difficulty in this reflecting in the simple linear regression is that a higher per unit expense does not translate directly into a larger or smaller amount consumed. Further, the establishment of suburban employment centers after the area is developed will change the employment potential values (and thus the accessibility) but will not generally affect the site sizes of the surrounding area (other than perhaps the immediate area).

No substantial relationships exist between the accessibility measures (distance from the core and employment potential) and dwelling value or income. This is in contrast to the bulk of the classical urban literature. This may be attributable to the nature and shape of the growth of the city, and to the historical establishment of higher income areas[2].

Overall, the simple linear regressions show there is no substantial relationship between the income distribution within Metropolitan Toronto and any single variable. By its converse, this suggests that the answer may lie in the combination of variables attained through multiple regression.

Lastly, when the dependent variables of dwelling value and income are individually plotted against each of the remaining variables a repeating funnel shaped pattern of data points occurs. This indication of heteroscedasticity must be examined when the independent variables are combined in the multiple regression analyses.

8.3 Multiple Regression

As discussed at the outset of this chapter, there are four components to be considered: household income (dwelling value or private household income); the composite good (held

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[2] Toronto's morphology was primarily star shaped until the post war period. Within this, some higher income neighbourhoods were established early and have maintained their status. Following World War II and extending to 1978, growth filled the interstitial spaces creating a more even peripheral boundary (Metropolitan Toronto Planning Department, 1978). See the previous discussion of the historical development of Toronto for more detail.

proportionally constant); a residential space component (site area, floor area or a composite area); and a transportation component (employment potential or distance from the core). For the multiple regression analysis, the first component holds the two dependent variables. The third and fourth components hold the two sets of independent variables. All possible combinations are listed in the Table 8.2 below:

TABLE 8.2: VARIABLE COMBINATIONS FOR MULTIPLE REGRESSION

Dependent	Independent	Independent
dwelling value	distance from core	site area
dwelling value	distance from core	floor area
dwelling value	distance from core	composite area
dwelling value	employment potential	site area
dwelling value	employment potential	floor area
dwelling value	employment potential	composite area
household income	distance from core	site area
household income	distance from core	floor area
household income	distance from core	composite area
household income	employment potential	site area
household income	employment potential	floor area
household income	employment potential	composite area

For each possible combination a scatterplot of the predicted versus residual values is created. This is done to detect heteroscedasticity. All the scatterplots exhibit a similar pattern - an increasing funnel shaped scatter of points.

Heteroscedasticity is the lack of equal variance of the error terms in a regression model. When this is the case, it results in the estimates of the regression coefficients (r) being inefficient (Intriligator, 1978). It will often cause a funnel shaped scatter of points when the dependent variable is plotted against the independent variable (Clark and Hosking, 1986). This was evidenced earlier in the discussion of simple linear regression. An appropriate approach to detect heteroscedasticity is to plot the residuals versus the predicted values (Gunst and Mason, 1980). If the data are homoscedastic (error terms with equal variances), the plot should illustrate a random scatter of points along a line with zero slope. If the data are heteroscedastic, an increasing horizontal funnel (increasing error variances) or a decreasing horizontal funnel (decreasing error variances) will result. In this circumstance, the use of ordinary least squares in the multiple regression analysis in no longer appropriate. Instead, weighted least squares (WLS) is used (Wonnacott and Wonnacott, 1979). This minimizes the impact of the observed values in the wide part of the funnel (Clark and Hosking, 1986).

The underlying philosophy is that greater errors occur in the observations in the wide part of the funnel of points, giving a less precise indication of where the true regression line should be drawn. It is thus suggested to be acceptable to pay less attention to these extreme values and to concentrate on the observations clustered in the narrow segment of the funnel cloud. This permits an appropriate fitting of the regression line by deflating the influence of the extreme values (Wonnacott and Wonnacott, 1979).

8.4 Weighted Least Squares Multiple Regression

The weighting is achieved by transforming the original multiple regression equation by dividing through by one of the independent variables. Then it can be regressed using standard multiple regression procedures[3]. The independent variable used is the one representing relative accessibility. Thus, two actual variables are used in separate iterations: distance from the core and employment potential. This component is selected because it influences (theoretically) the housing expenditure and/or availability, and it generally shows the greatest degree of heteroscedasticity, compared to the housing consumption variables. Table 8.3 lists the adjusted R^2 values for the possible regression equation combinations.

TABLE 8.3: ADJUSTED R^2 VALUES FOR WLS MULTIPLE REGRESSION

Equation Variables	Weighting Variable	Adjusted R^2
value/floor area/distance	distance	---
value/site area/distance	distance	.262
value/composite/distance	distance	.404
income/floor area/distance	distance	---
income/site area/distance	distance	.131
income/composite/distance	distance	.235
value/floor area/potential	potential	.376
value/site area/potential	potential	.501
value/composite/potential	potential	.563
income/floor area/potential	potential	---
income/site area/potential	potential	.341
income/composite/potential	potential	.421

n = 117

[3] For the algebraic transformation, see Wonnacott and Wonnacott (1979). For a more simplistic explanation, see Clark and Hosking (1986).

Three general trends are evident. First, the adjusted R^2 are substantially higher when the employment potential measure is used as the weighting variable. Second, dwelling value as the dependent variable provides a better explanation than does income. Third, of the three area measures, the composite variable performs best, followed closely by site area and lastly by floor area.

Expanding upon these trends, it appears that consideration of the potential opportunities spread throughout the city on a location's relative accessibility is more informative than simply distance from the core. This implies the assumption of monocentricity is not useful in assessing intraurban income distribution. Using the employment potential measure overcomes the assumption of a mono/poly/non-centric city.

Further, the goodness of fit is improved when the dwelling value is used as the subrogate for household income. This raises two points. First, actual private household income, perhaps due to the inherent pitfalls discussed previously, is not a good measure of the level of income necessary to buy a home at in a certain location. Second, the bulk of the literature uses income as a important variable, when perhaps other variables are better suited to represent the level of capital expenditure necessary. Thus, while perhaps initially confusing, reported income is a poor measure of theoretical income.

Using different space measures creates distinct effects. When the full study area is considered, the average floor area is the least penetrating of the three (R^2=.376, when combined with dwelling value and employment potential). The use of site area contributes to significantly explaining approximately half of the dwelling value distribution (R^2=.501, for the similar combination). Thus, this measure is much stronger than the floor area based component. Yet, when these two measures are combined, the best results are gained in all iterations (in comparison to floor and site areas, R^2=.563).

This may be attributable to the historical nature of development. When land space is not at such a premium, it is characteristic to see small homes on large lots. This would deflate the dwelling value for this instance. Older larger homes with ample floor space may not hold the predicted value because of their age, quality of structure, quality of neighbourhood, etc. Another factor may be the lower demand for five and six bedroom homes, creating a deflated submarket. When these areal units are combined, a better representation of the total housing bundle is obtained. Still, the goodness of fit is limited.

It is also postulated that the dwellings and sites to be most affected by the peripheral containment of space are those with greater space. This should lead to a greater revaluation of their values as compared to locations of less space. Thus, one may expect stronger relationships to exist within the medium and high value sectors than within the low sectors. The potential contradiction to this is the presence of high value dwellings whose value is predominantly due to very high accessibility. This is more applicable to luxury condominiums than single detached development, and thus is not considered to pose any serious distortion in the sectoral relationships.

To examine this postulation, the weighted least squares multiple regression procedure discussed above is applied to each sector, to observe any meaningful differences between sectors. In addition, it may provide supplemental weight for the notion of sectoral analysis versus treating the study area as an entity only.

8.5 Weighted Least Squares Multiple Regression by Sector

A weighted least squares multiple regression is performed for each of the six sectors identified previously, for each of the space, value/income and accessibility measure combinations. The weighting variable is the appropriate relative accessibility measure. Table 8.4 lists the results, by sector, for the combination of dwelling value (dependent), the two relative accessibility measures (independent) and the three space measures (independent). The results based on income as the dependent variable have been omitted from this table, due to the better explanation provided by dwelling value[4].

TABLE 8.4: ADJUSTED R^2 VALUES BY SECTOR

Sector: Equation Variables	6	5	4	3	2	1
value/distance/floor area	.080	.807	.615	.181	---	.210
value/distance/site area	.371	.507	.604	.345	---	---
value/distance/composite	.104	.707	.687	.390	---	---
value/potential/floor area	.168	.602	.591	---	.314	.394
value/potential/site area	.290	.451	.495	.197	---	---
value/potential/composite	.210	.688	.724	.228	---	---

sector =	6	5	4	3	2	1
n =	46	20	18	21	5	6

The most obvious assertion to be made from these R^2 values is that the goodness of fit in sectors 4 and 5 is far superior to the remaining sectors. This holds true in all combinations of variables. Within these sectors, calculations based on the floor area measure show stronger relationships than those based on site area, and are generally similar to the composite values. However, when sectors 3 through 6 are examined, the reverse is true. The

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[4] The results of the weighted least squares multiple regression for the dependent variable income, by space and accessibility measures, by sector, are listed below:

ADJUSTED R^2 VALUES FOR WLS MULTIPLE REGRESSION BY SECTOR

sector / variable combination	6	5	4	3	2	1
income/distance/floor	.036	.330	.376	.180	---	---
income/potential/floor	.163	.420	.354	---	---	---
income/distance/site	.310	.472	.214	.350	---	---
income/potential/site	.239	.496	.301	.337	---	---
income/distance/composite	---	.484	.244	.295	---	.608
income/potential/composite	.213	.581	.438	.317	---	---
n =	46	20	18	21	5	6

weak results for sectors 1 and 2 are reflective of the small sample size available for each.

The goodness of fit in the medium and high sectors reinforces the notion that the relationship holds better for the dwellings that have higher values. Further, it provides supplemental weight for the notion of including sectoral analysis versus only dealing with the full study area. This is in contrast to the classical models of land rent, which treat the study area as a whole, insofar as differences are confined to "distance from the core". In such cases, discussion of the "periphery", for example, considers all locations along this outer boundary to be the same, as long as the distance from the core is the same. It does not allow for the historical creation of sectors of economic status.

Based on the results of the regressions performed, the appropriate variables are combined to predict dwelling values. This procedure is reiterated for each of the residential space measures. The spatial distributions of these are discussed in the next chapter.

CHAPTER 9:

EMPIRICAL ANALYSIS III: PREDICTED VALUE DISTRIBUTIONS AND CLUSTER ANALYSIS

9.1 Introduction

The distributions of the predicted dwelling values for each space measure are displayed in Figures 9.1 to 9.3; the pattern of actual dwelling values is shown in Figure 7.11. Data for the predicted values represent the block level; the actual dwelling values are based on block-corresponding enumeration area data. The three sets of predicted values are the results of the multiple regression analyses based on the following iterations (see Table 9.1):

TABLE 9.1: VARIABLE COMBINATIONS USED FOR PREDICTED VALUES

Dependent Variable	Independent Variable	Independent Variable	Weighting Variable
dwelling value	floor area	potential	potential
dwelling value	site area	potential	potential
dwelling value	combination	potential	potential

The mapping categories are based on the dispersion of the actual values, i.e. the average and standard deviation of the actual dwelling values are used. These categories are applied to each of the four maps, to enhance comparability. Evaluation of the spatial patterns, discussed below, provides greater insight into the significance of the predicted values and the applicability of the model.

9.2 1986 Actual Dwelling Values (enumeration area-based)

The pattern of 1986 actual dwelling values (Figure 7.11) shows the majority of the study area contains enumeration areas of dwellings purported to be in the below average category ("average to minus one standard deviation", predominantly). The major spatial presence of this value range is not surprising, considering that (i) the average might be pulled upward by a limited number of blocks of very expensive homes (and that this would have a greater effect than the downward pull of cheap homes), and that (ii) the concentration on single detached dwellings removes the influence of the relatively inexpensive higher density forms of housing. Further, casual observation suggests that most cities are primarily comprised of housing that is within a relative median price range, with fewer nodes of expensive or inexpensive units.

The above average dwelling values are contained within sectors 2, 4 and 5, for the most part (33 of 37 enumeration areas); these are the sectors identified earlier as either "high" or "medium" value. It is argued that the upper end of the single detached housing market is composed of larger houses and/or larger lots. Further, these values are accentuated by greater accessibility. The distinct spatial clusters of the units in the highest value category are also reflective of the maintenance of some of Toronto's high income neighbourhoods over time.

9.3 1988 Predicted Dwelling Values (site area-based)

The distribution of predicted values based on site area as the space measure (Figure 9.1) results in a pattern that is comparable with Figure 7.11. Sixty percent of the blocks (21 of 35) designated as above average value directly correspond with the enumeration areas in this category. These are found in the high and medium sectors, in almost all cases (19 of 21). The remaining forty percent (14 blocks) predicted to have above average values are scattered. Further, they tend to be situated in the older suburban areas between the core than the periphery. These may reflect the greater predicted valuation of accessibility, in combination with space. Overall, the number of above average value blocks is similar to the number of enumeration areas in this category (35 predicted, 37 actual).

9.4 1988 Predicted Dwelling Values (floor area-based)

The predicted value distribution based on floor area is shown in Figure 9.2. There are 49 blocks predicted to be above average in value. This is considerably higher than the number based on actual values (37). While there is substantial overlap (29 of the 37 actual above average value blocks were predicted), more blocks toward the periphery were calculated to have above average value than in either of the two preceding figures. This may be reflective of the recent trend (relative to the remainder of the study area) toward smaller lots in combination with larger dwelling areas. In

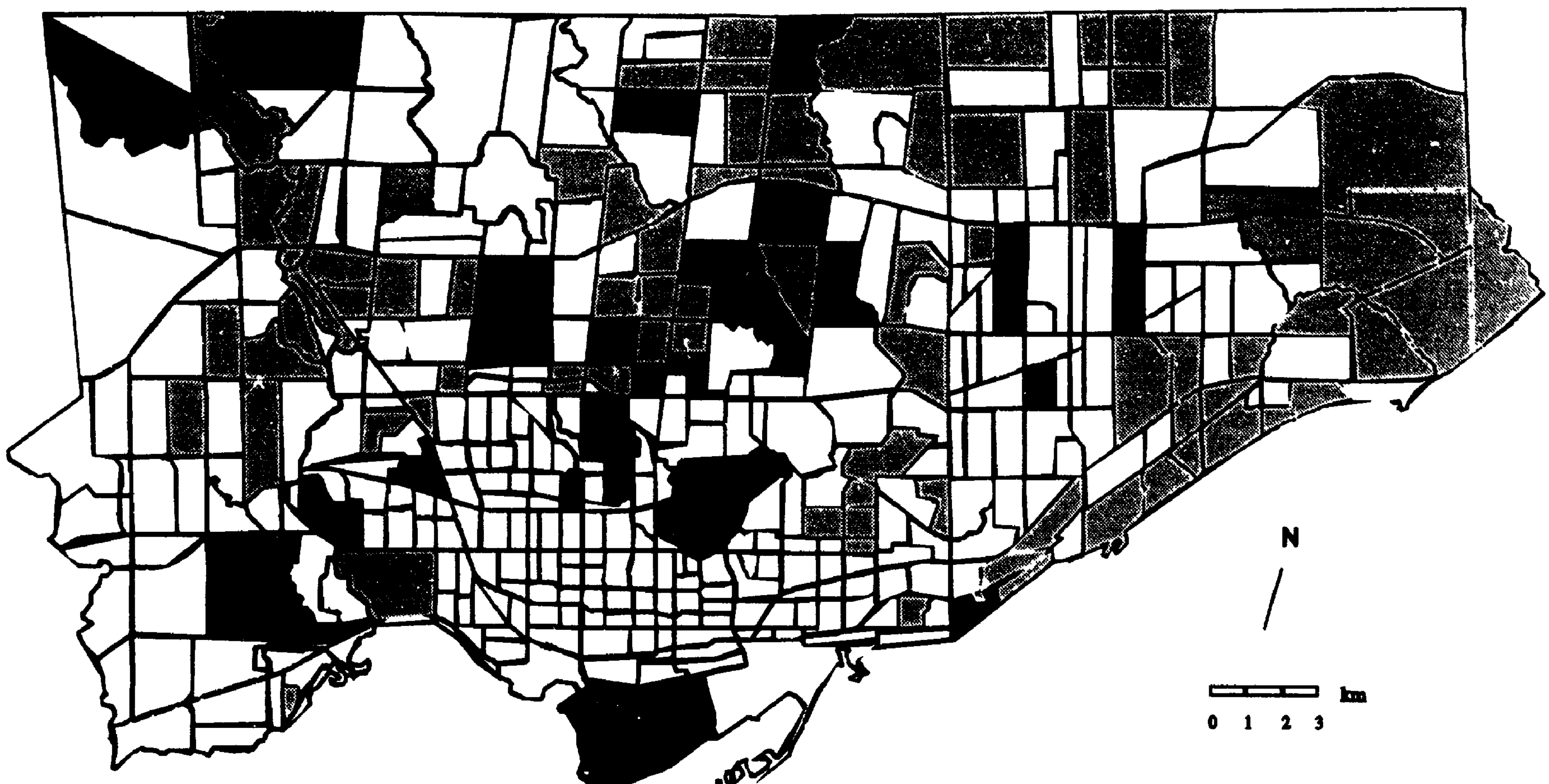

Figure 9.1: 1988 Predicted Dwelling Value (site area-based)

> +2 s.d. | > +1 s.d. to +2 s.d. | > average to +1 s.d. | average to -1 s.d. | < -1 s.d.

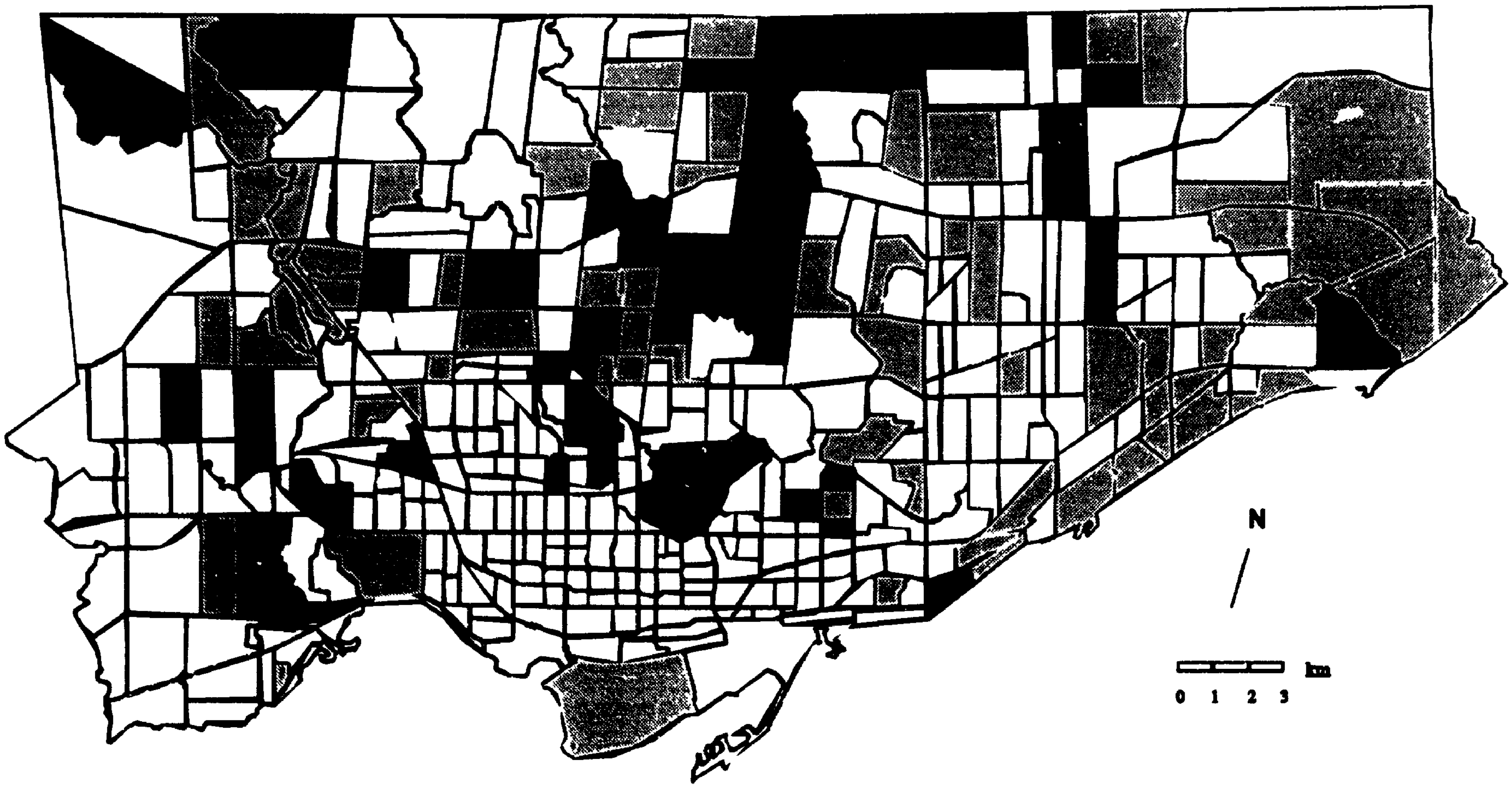

Figure 9.2: 1988 Predicted Dwelling Value (floor area-based)

> +2 s.d. | > +1 s.d. to +2 s.d. | > average to +1 s.d. | average to -1 s.d. | < -1 s.d.

addition, there are no blocks predicted to have values in the highest category. This may suggest an undervaluation at the top end of the value scale and an overvaluation in the middle range. While it may be argued that the sectoral pattern is evident, especially in sectors 4 and 5, it is somewhat clouded by a greater dispersal of above average value blocks than shown previously.

9.5 1988 Predicted Dwelling Values (composite area-based)

Once again, the overall spatial pattern that is predicted (Figure 9.3) coincides with that of the actual dwelling values. With respect to the above average value blocks, this combined space measure contributes to a slightly different pattern than those discussed above. It identified 45 blocks in this general category. Over three quarters of the actual above average blocks (from Figure 7.11) are included. The distribution of the remaining blocks is similar to other predicted maps, as one would expect. Generally, it contains slightly fewer peripheral cases of above average value than the floor area-based prediction, with a greater dispersion than that shown in Figure 9.1 (site area-based values). This again is not surprising, considering the number of blocks predicted to be above the average (45 versus 49 and 35, respectively).

Overall, the existence of some distinct sectors is reinforced. The concentration of above average (actual and

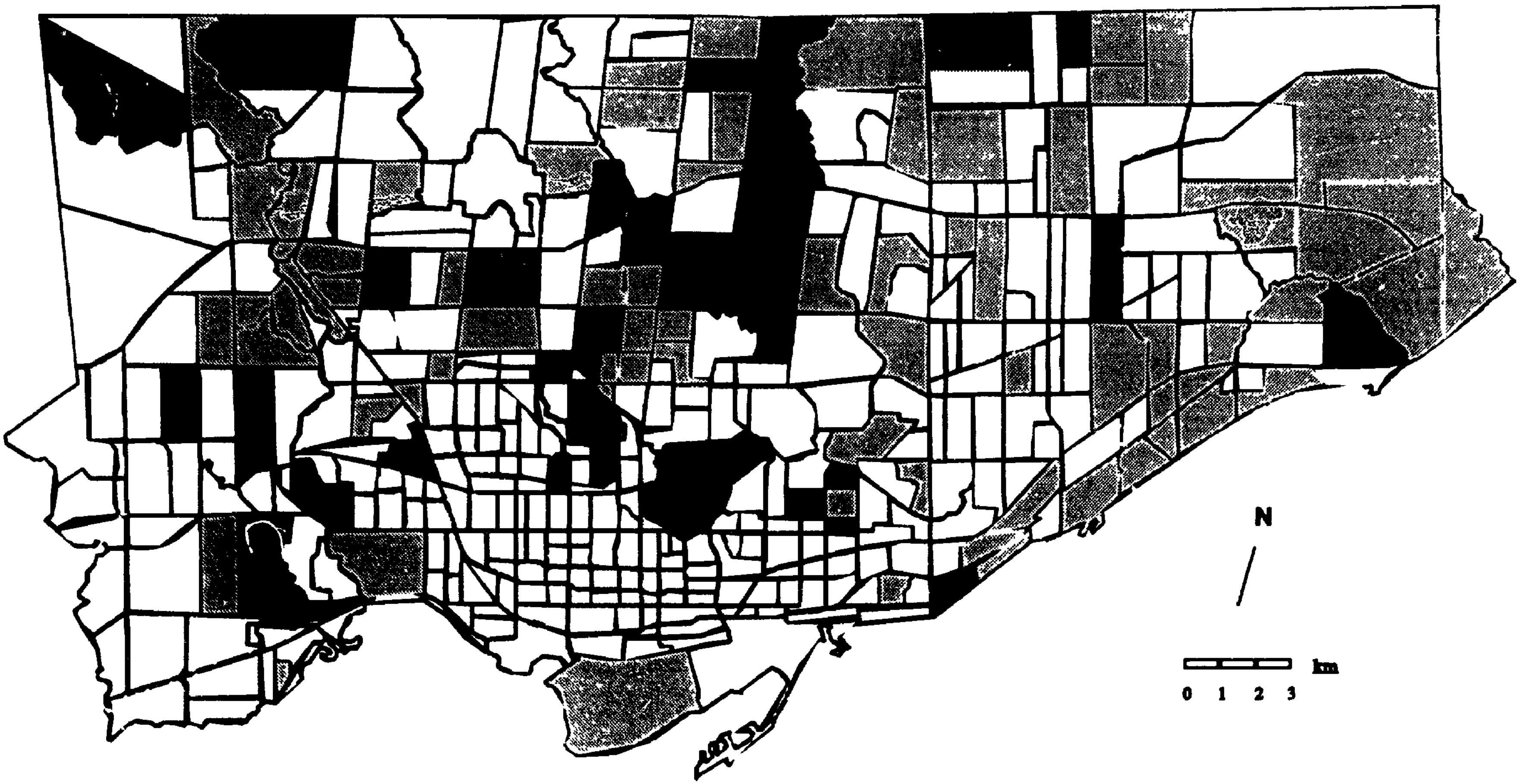

Figure 9.3: 1986 Predicted Dwelling Value (composite area-based)

> +2 s.d.   > +1 s.d. to +2 s.d.   > average to +1 s.d.   average to -1 s.d.   < -1 s.d.

predicted) values in sectors 4 and 5, and to some extent 2, reflects the importance of the variables addressed and the historic presence of these sectors. The predicted values are reasonable subrogates for the actual dwelling values, especially in the higher value ranges. What still remain to be explained are the predicted above average value blocks that do not fall within the medium or high sectors.

Generally, the bulk of the predicted blocks concurs with the actual distribution. Some discrepancy lies is in the number of above average dwelling value blocks predicted, but the majority of these correspond to the actual higher dwelling value units. It may be possible that these "additional" predicted high value blocks (i.e. those predicted blocks that do not correspond with the actual above average dwelling value blocks) have not yet reached the level necessary to be "above average", but are increasing to a greater extent relative to other similar blocks. This may infer areas that are beginning to experience renewal or some form of gentrification or upgrading.

Further, these "extra" predicted blocks may reflect the fundamental notion that peripheral containment is resulting in a revaluation of existing lots, with the larger lots rising in value faster than smaller ones. This can be coupled with accessibility, the second major component in the budget equation and contributory to the theoretical level of income necessary to reside at a relative location. It is postulated that, for lots with similar accessibility, those with larger site sizes will increase in relative value to a greater extent than those with smaller site sizes.

This may help explain the "additional" predicted above average value blocks i.e. these blocks are rising in price more quickly than the other blocks in their accessibility group. Given enough time, these predicted blocks will gain "above average value", while their accessibility counterparts may not. The same premise can be applied to all blocks having similar accessibility levels, regardless of their current value categories.

9.6 Cluster Analysis

This postulation is assessed through the comparison of relative accessibility, relative site area, and relative value change. To calculate relative dwelling value increase, the percent change in value from 1971 to 1986 is determined for each block-corresponding enumeration area. This time period is selected for its internal geostatistical boundary homogeneity and long term base[1].

Cluster analyses are performed at two levels for both the

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[1] Please refer to the discussions in the Method and Analysis I sections for additional justification of this time period selection.

employment potential variable and the distance from the core variable. These result in five and ten internal categories or groups per variable, respectively.

Initially, five different levels of aggregation were performed in the cluster analyses, for each variable. The degree of variation with respect to the resulting number of categories is limited, but still variable (see Table 9.2 below)[2].

TABLE 9.2: INITIAL CLUSTER ANALYSES AND RESULTANT NUMBER OF CASES

accessibility variable	# of clusters specified	# of groups of cases
distance from the core	5	5
distance from the core	7	7
distance from the core	10	8
distance from the core	15	10
distance from the core	20	13
employment potential	5	3
employment potential	7	5
employment potential	10	6
employment potential	15	10
employment potential	20	12

The end result is the selection of levels of clustering that provide (i) the same number of categories to permit comparison between the two accessibility variables, and (ii) a reasonable difference in the number of categories provided

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[2] These reflect some merging to satisfy the assumptions necessary to perform the Spearman's rank correlation coefficient (discussed later).

by each cluster analysis level to allow for substantially distinctive degrees of detail. Thus, the applications resulting in five and ten groups in each variable are chosen.

Within each category of similar accessibility (i) site area is ranked from largest to smallest, and (ii) percent change in dwelling value is ranked from largest to smallest. The use of ranks facilitates the measurement of the strength of the association between them. It clarifies this relationship insomuch as the use of absolute values clouds the results due to the variability of amount of percent change between the various site sizes.

Further, it is the primary relative relationship of "larger size/larger increase" versus "smaller size/smaller increase" that is of importance here. The amount of absolute change is affected by the market/planning/social conditions in existence at the time. These may vary significantly for different spatial or temporal periods, while the primary relationship may still hold for these periods.

The primary relationship is hypothesized to be that:

> for lots with similar accessibility, the relative value gain will increase with increasing lot size.

In other words, relative value change (X) is positively correlated with relative site area (Y).

To test this hypothesis, the strength of the association between the relative rankings is measured using the Spearman's rank correlation coefficient. The significance of this association is assessed by using a one-tailed *t* test (Siegel, 1956).

Tables 9.3 and 9.4 list the coefficients for the groups in each of the cluster analysis levels, for each accessibility variable. The rankings are listed in reverse order to provide easier comparison. For the distance from the core variable, the largest category (i.e. #1) contains the blocks that are the farthest away from the core - in other words, the least accessible. For the employment potential variable, the largest group (i.e. #1) contains the blocks that have the highest potential values - in other words, the most accessible. Thus, reversing the order of the employment potential groups provides a consistent ordering of least accessible group to most accessible group for both variables.

TABLE 9.3: SPEARMAN'S RANK CORRELATION COEFFICIENTS - 5 GROUPS

Distance from the core			Employment potential		
Group Number	Correlation Coefficient	Sig. at .05 (*)	Group Number	Correlation Coefficient	Sig. at .05 (*)
1	.4651	*	5	.5853	*
2	.3897	*	4	.4450	*
3	.5103	*	3	.2107	
4	.4480	*	2	.5172	*
5	.5901	*	1	.4333	

TABLE 9.4: SPEARMAN'S RANK CORRELATION COEFFICIENTS - 10 GROUPS

Distance from the core			Employment potential		
Group Number	Correlation Coefficient	Sig. at .05 (*)	Group Number	Correlation Coefficient	Sig. at .05 (*)
1	.4286		10	.7902	*
2	.6778	*	9	.3500	
3	.4622		8	.5500	*
4	.3091		7	.3696	*
5	.8536	*	6	.5118	*
6	.4488	*	5	.4110	
7	.6485	*	4	.0286	
8	.4572	*	3	.0857	
9	.7182		2	.7500	*
10	.8273	*	1	.4333	

These results support the acceptance of the hypothesis. It is evident at both levels of aggregation that there is a strong relationship between the rank of site size and the rank of percent value increase within groups of similar accessibility. This holds true for both measures of accessibility.

There are no notable patterns discernable between general levels of accessibility. In other words, areas of higher accessibility do not show a consistently stronger (or weaker) association than areas of lower accessibility. A slight difference exists between the two accessibility variables with distance from the core exhibiting slightly stronger correlations, but this too is not dramatic.

The statistical procedure is also applied to the study area as a whole, for the two levels of aggregation (Table 9.5).

For each cluster analysis level, all ranked cases from each cluster are combined into one data set. This is done to help expose any notable difference between the two levels of detail.

TABLE 9.5: SPEARMAN'S RANK CORRELATION COEFFICIENTS

Accessibility Variable	Total # of Groups	Correlation Coefficient	Significance at .05 (*)
distance from the core	5	.6396	*
employment potential	5	.5681	*
distance from the core	10	.6113	*
employment potential	10	.6052	*

The results illustrate similar levels of association between the two levels of aggregation. Within each level, the distance from the core variable provides slightly higher coefficients, although all results are significant at the 5 percent level. Thus, when the analysis treats the study area as an entity i.e. takes on a nonspatial framework, the accessibility variable using distance from the core improves its quality of contribution, to a modest extent.

In sum, all of the cluster analyses illustrate that for residential lots with similar accessibility, the relative dwelling value gain will rise with increasing lot size. Thus, the fundamental premise of the model is supported. Further, the spatial distributions of the predicted dwelling values correspond to the actual values, to a reasonable extent.

The differences that exist between the predicted and actual levels of dwelling value may be explained in part by the nature of the data. Given the points that the revaluation is mostly easily seen in the resale market (i.e. individual houses versus subdivision level), and that the measurements reflect block (or enumeration area) aggregation, it is likely the data will mollify the degree of revaluation recorded. Further, in light of the recent nature of this trend, the varying extent of value change may not be significantly revealed in the 1986 census values. This "hidden" aspect may continue to uncover itself over time, as the revaluation is occurring at disproportionate rates (as illustrated in the cluster analyses). Summary assessments of the basic logic and of the model's performance, considering all of the analyses, are provided in the final chapter.

CHAPTER 10:

CONCLUSIONS

10.1 Précis

The dissertation examines the residential location pattern of socioeconomic groups in a metropolitan center. Suburban land consumption constraints and a polycentric urban structure are incorporated into a budget equation-based model. The model is empirically tested using data for Metropolitan Toronto.

The model is based on the notion that the consumer's selection of the residential site and situation can be simplified to the basic components of space, location and income. Two constraints limit the selection open to the household. The first is the level of theoretical income, which places a ceiling on the amount that can be spent on housing, goods and services. The second limitation reflects the presence of lot size restrictions on new and recent development at the periphery of the metropolitan center. The latter replaces the assumption of greater quantities of land available at increasing distance from the core (characteristic of traditional urban-economic models). Further, it confronts the space-seeking consumer with different options than those held in the previous literature: larger sites are available either at a much increased distance from the center (greatly reducing accessibility), or at established locales closer to the core. Those consumers who can not obtain greater space, will revaluate those locations with increased levels of access to attractions.

The model combines a relative quantity of space (dwelling floor area, site area or a composite measure), a relative value of accessibility (distance from the core or employment potential) and an allotment of goods and services (held proportionally constant). These represent the total expenditure of the theoretical household income. Based on actual space and accessibility data, the required theoretical income to live at that relative location is predicted. This value is compared with the actual relative quantity (based on household income or estimated dwelling market value). The distributions throughout Metropolitan Toronto are compared using different descriptive and statistical methods.

In accordance with the model, the household is faced with two choices to obtain residential space that is greater than at the periphery. First, it may locate well outside the metropolitan center beyond the area of lot size restriction, sacrificing accessibility to a great extent. Second, the household may select an older, larger lot within the metropolitan center. This may or may not enhance accessibility. Alternatively, when faced with the potential lack of greater space, the household may opt to select a location with improved accessibility. The end result within the metropolitan center is that the space restriction will force a revaluation of relative location. In the case of a city with a dominant CBD, higher income groups shift geographically inward; in a polycentric center, areas that contain greater space and better accessibility increase in relative value.

10.2 Spatial and Temporal Patterns

Through the first twenty years of the study period (1961 to 1981) two major trends happened. First, there was a gradual outward movement of the areas of above average value from the "middle" region of Metropolitan Toronto toward the periphery. Second, there was an historical maintenance of high value sectors or locales. These are in accordance with the traditional urban-economic models.

During the most recent decade of the study period (i.e. 1980s), there was a growing trend of declining relative value near the periphery, and increases in value in areas near the "middle" to "inner" regions of the study area. This does not correspond to the traditional contributions, nor is the relative location fully explained by gentrification conjectures.

Similar patterns were evident in the examination of the percent change in dwelling value. The larger increases occurred toward the periphery in the earlier periods, as the areas underwent suburbanization. During the 1970s, the speculative boom and the controls on new dwelling supply contributed to the relative increases in value in the inner areas. These areas contained some of the lower value dwellings, contributing to the resultant larger percentage increases (even though the relative prices may not have changed significantly). The inner areas also contain the recent and current locales of gentrification occurring in Toronto.

Of specific concern is the trend that occurred in the 1980s. Various locations near established high value districts experienced high percentage increases in estimated dwelling worth, as did areas in the "middle" and "middle to inner" regions. These changes do not mean that the values reached a high level, only that revaluation was greater than other areas within Metropolitan Toronto. However, this revaluation is not explained by either the traditional urban-economic models or the gentrification literature. It is explained, in part, by the theoretical premise of the dissertation.

Lastly, the spatial and temporal trends revealed the continued existence of a sectoral organization of higher value districts. The maintenance and influence of this arrangement suggested the need to perform sectoral analyses in addition to those applied to the full study area. Further, this two pronged approach allowed the inclusion of aspects of Toronto's historical development in the investigation, by recognizing the continued existence of sectors of higher dwelling value, and not simply assuming identical (at the outer edge) concentric growth over time.

10.3 Examination of the Variables of the Model

The model is based on four components (income, space, accessibility, and goods/services), each measured through different variables (listed above). Initially, simple linear regressions were performed on all possible pairs of variables[1] to identify any strong relationships.

Weak relationships were found between dwelling value and the space measures (although these were stronger than those calculated when income was used). This may suggest that relative value is determined by more than onsite characteristics. It further implies that dwelling value is an improved measure over household income.

The only moderately strong relationship was found between dwelling value and income. This was expected as these two variables were proposed to be partial subrogates. The modest association between the accessibility variables (distance and employment potential) implies the traditional assumption of monocentricity is moot at best. Further, the standard assumption in the urban-economic literature of increasing

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[1] The composite area measure was not regressed against the site area or floor area values because of the nature of its calculation, i.e. it would have resulted in the composite area measure being partially regressed against itself.

space with increasing distance does not hold. This reflects the inappropriateness of assuming a concentric urban form and the need to reflect both historical patterns of growth and recent/current land development policies or directives.

Overall, the lack of any strong relationship being revealed through simple linear regression led to the conclusion that the income/dwelling value distribution was not simply explained by a solitary variable. This supported the fundamental concept of the model i.e. that the household location pattern can be explained through the combination of relative space, relative location and relative income.

To assess the possible different combinations of the model's variables, weighted least squares multiple regressions were performed. The accessibility measure was used as the weighting variable. Three initial conclusions were reached: first, employment potential provided a better goodness of fit than did distance from the core (R^2 = .501 or .563 versus .262 or .404, respectively)[2]; second, dwelling value as the dependent variable (versus household income) improved the explanation (R^2 = .501/.563 versus.341/.421)[3]; and third, the composite space measure and the site area value performed

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[2] The R^2 values are for site area and composite area respectively, when combined with dwelling value.

[3] The R^2 values are for site area and composite area, respectively, when combined with employment potential.

best in the model in all combinations of variables, and especially when it was combined with employment potential and dwelling value (R^2 = .563 composite, .501 site, .376 floor).

The use of the employment potential calculation not only improved the goodness of fit, but also overcame the redundant assumption of monocentricity. Further, it permits the incorporation of different city forms (poly/mono/non-centric) without changing the basic theoretical structure of the model. This provides greater flexibility in the model's application, and it can better reflect current urban structures than previous approaches.

The use of dwelling value as an indicator of household spending power on housing was a refinement over the use of income. The limitations involved in the use of actual household income (discussed previously) prevented it from being as indicative of potential household expenditure levels. Simply put, dwelling value is a better indicator of the relative income required to live at a certain location than is actual income.

The use of site area improved the goodness of fit of the model over that achieved using floor area. This may reflect a variety of factors, such as the changing nature of submarkets (i.e. shifts in housing preference), the ability to alter the character and size of the structure, the differing effects of aging on the housing bundle components, the changing structure of planning objectives, and the historical nature of urban development and technology. It may also reflect the difficulty in amassing more site space by the consumer.

The use of the composite space measure provided the best results, revealing that floor area was contributory to a degree and worth regarding. However, site considerations were the stronger influence. This is logical in that, hypothetically, one could build a certain size and style of house anywhere in the city. It is not as easy to assemble any size lot desired. This is currently being borne out in Metropolitan Toronto with the demolition of small post war bungalows situated on large lots and their replacement with large "monster" homes, discussed in Chapter Four.

When the multiple regression analyses were performed by sector, the higher value sectors improved the goodness of fit significantly (the R^2 for the value/composite/potential iteration for sectors 4 and 5 are .724 and .688, respectively). The lower value sectors showed a much weaker trend. This supports the view that the model will likely hold better in areas with greater space and/or accessibility characteristics - i.e. typically (but not exclusively) the above average value sections. These are the ones most likely to be revaluated first (as it is the higher income households that theoretically have "first choice" due to better purchasing power). In addition, and following on the principles of Hoyt (1939), areas next to the high value locales will likely be comprised of dwellings of moderate-to-high worth. Plausibly, these will contain larger residential spaces than districts of moderate-to-low value. Thus, these areas should be the next to revaluate to a greater extent.

10.4 Predicted versus Actual Dwelling Value Distribution

The pattern of above average dwelling values based on the enumeration area data conformed to a sectoral arrangement for the most part (33 of 37 blocks). The four blocks that were not in or near these sectors were found in a locality near the core and the lakeshore (2 blocks), and in the northeast corner where the largest amount of vacant land in Metropolitan Toronto was located (1 block). The remaining block was adjacent to one of the historic nodes of high value, but was not "cartographically" within that sector.

The pattern of predicted dwelling values based on site area reinforced the sectoral arrangement. The predicted above average value blocks that were not within these districts were scattered within the older suburban areas. This may reflect the combination of larger, older lots and the better accessibility afforded by their locations. The total number of higher value blocks predicted was comparable to the actual number (35 and 37, respectively).

The results from using floor area data in the model were somewhat different, except for the continued presence of the upper scale sectors. There were more above average value blocks identified than in either the site predictions or the actual distribution. Further, the predicted blocks that were not in the higher price sectors were mostly toward the periphery. This may reflect the recent trend of larger dwellings (regardless of lot size) in combination with the level of accessibility. Overall, the presence of sectors was again reinforced.

When the composite area measure was used in the model, the general predicted pattern again corresponded with the actual one. Aside from the continued sectoral emphasis, the remaining blocks were scattered, with fewer toward the periphery than in the floor area data iteration.

These patterns provide a number of conclusions. First, the presence of a sectoral arrangement was mirrored in all of the space measure iterations. Thus the predicted distributions, especially in the cases of the site area and composite area applications, correspond to the real pattern.

Second, the model is capable of reflecting the historical nature of development, and is not bound by the assumptions of urban structure characteristic of traditional urban-economic models. This is especially true with regard to lot size restrictions, and the continued presence of high value neighbourhoods.

Third, while the prediction of blocks in the "middle" to "outer" regions as being above average value was not supported by the 1986 actual values, these relative locations do correspond to the general areas currently undergoing residential red^velopment (such as the changes occurring in North York, discussed in Chapter Four). Thus, while the blocks in question may not be "higher value" yet, it is possible that they will attain that status (or at least undergo a significant percentage increase in value).

10.5 Evaluation of the Fundamental Premise of the Model

The basic supposition is that the restriction of lot size at the periphery, such as would result from policies of peripheral containment, will force a revaluation of existing lots. This, in combination with the site's relative accessibility, will lead to different degrees of revaluation. Accordingly, for lots with similar accessibility, larger sites will rise in relative value to a greater extent than smaller ones.

A crude indicator of this revaluation was the 1980s trend of percent in change in relative dwelling values: these declined near the periphery and increased in the "middle" and "inner" areas. This may infer that the larger lots (and often smaller houses) of the early post war era, located in the older suburbs, are undergoing a revaluation that differs in its degree from the newer lots and houses at or near the Metropolitan Toronto fringe.

The stronger performance of site area (over the floor area measure) in the regressions and in the predicted value distributions, suggests that lot size and its containment is an important contributor to the extent of revaluation.

Of particular interest were the results of the cluster analyses. These were performed at two levels of aggregation for both the accessibility variables; within each cluster, Spearman's rank correlation was applied to site area and percent change in dwelling value. The bulk of the clusters, at both levels of aggregation and for both accessibility variables, resulted in correlation coefficients that are significant at .05. This supports the acceptance of the basic premise that constraining lot size at the edge of the built up area will result in a revaluation of existing parcels.

10.6 Summary Assessment of the Model

Overall, the model performed reasonably well. While the R^2 values for the full study area were not dramatically high, they were much improved in the higher value sectors. This contrasts the basic notion of much of the traditional literature that assumes growth to be concentric and identical along the periphery at any point in time. In addition, it confirms the importance of recognizing sectors. These historically maintained districts will affect revaluation and distort any expected, simplistic concentric pattern. The spatial patterns of the actual dwelling values and the predicted values corresponded well and improved the applicability of the model. Further, the testing of the fundamental logic or hypothesis also proved to hold up well.

The performance of the space measures supported the notion of the importance of site size in the residential selection process. Further refinement of the composite variable, in terms of the weighting of the proportions of the two components, may provide improved representation.

The accessibility variables displayed different strengths. When similar levels of access were grouped together, creating essentially a nonspatial landscape within that group (such as in the cluster analyses, for example), the measure of distance from the core performed reasonably well. In contrast, the employment potential measure was superior when the spatial distribution was incorporated. Testing of the two measures in an environment that is not influenced to the same extent by development constraints (such as greater Los Angeles) will provide additional insight into their relative strengths.

One drawback is the inability to reasonably assess areas that are currently undergoing (or have recently undergone) significant revaluation, before their establishment of new relative values at the enumeration area level. This is notable for Metropolitan Toronto, in which the residential redevelopment discussed is a recent (and current) phenomenon. Further, while new developments are built at the block or subdivision level, redevelopment of single detached dwellings is often tackled site by site (and often by households versus developers). It may be that the model will increasingly improve its goodness of fit over the next decade, as recent and current changes increase in quantity and alter the enumeration area-aggregated statistics to a greater degree.

10.7 Contribution to Geography

From a conceptual perspective, the model is a significant improvement from past related works in that it includes the historical and morphological structure of the center. It is not necessary to assume a concentric expansion of the urban structure (certainly not the case for Toronto), nor the increasing availability of land at the periphery. The model also allows the continued existence of old upper income nodes within the city.

The inclusion of an accessibility variable, other than distance from the core, is another notable improvement. While there may be methods other than an employment potential calculation to measure a location's accessibility, the importance of incorporating an urban form that is potentially not monocentric is paramount today.

Further, the inclusion of elements outside of "pure market forces" (in this case planning directives to restrict lot size), enhances the model's ability to replicate (while simplifying) the real world. Different types of constraint could be incorporated: commuting difficulties, limits to the spatial extent of essential municipal services, (or the opposite scenarios), etc. The growing pressure for sustainable communities and limits to spatial expansion at a variety of levels may also increase the applicability of the model.

The "centripetal shift" model contributes to the existing literature on urban form and land rent. It embodies elements of city structure and planning policies. It overcomes some of the constraints inherent in the assumptions of the traditional models, while at the same time showing their continued applicability (albeit in a modified form) to today's study of urban morphology and physiology. Further, it implicitly permits the historical nature of development and the effects of changing technology to be incorporated into the urban structure.

The model also provides an alternative explanation to elements of gentrification. Its application is not restricted to the inner city; it can include a larger picture of the housing market i.e. it does not distinctly separate the inner city from the suburbs. In addition, this approach contributes to the examination of policy effects outside the central city on the changing intraurban income distribution occurring within. The model lends support for the direction of economic explanations of gentrification (i.e. the basic approach of the rent gap with regard to revaluation).

There are also implications for research on accessibility and its contribution to the residential location decision. This is an area whose impacts are not clearly outlined, nor is there consensus on the most appropriate method of measurement. Its importance is, nonetheless, apparent.

In sum, the quality of the model's performance justifies future efforts toward its refinement and subsequent testing. It supports the view that the application of traditional models in non-traditional ways is an area worthy of examination. While the changing structure of urban areas leads to new requirements in geography for models that are appropriate for present day cities, the fundamental principles of past theoretical foundations still hold. Thus, through the modification (or modernization, in effect) of the time-tested models, the realities of today can be better incorporated.

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